No. 7-A

RADIO TRANSMITTER

INSTRUCTIONS
FOR USE

Western Electric Company

Instruction Bulletin No. 411

The equipment described in this Bulletin
was designed and developed for the

Western Electric Company

by

BELL TELEPHONE LABORATORIES

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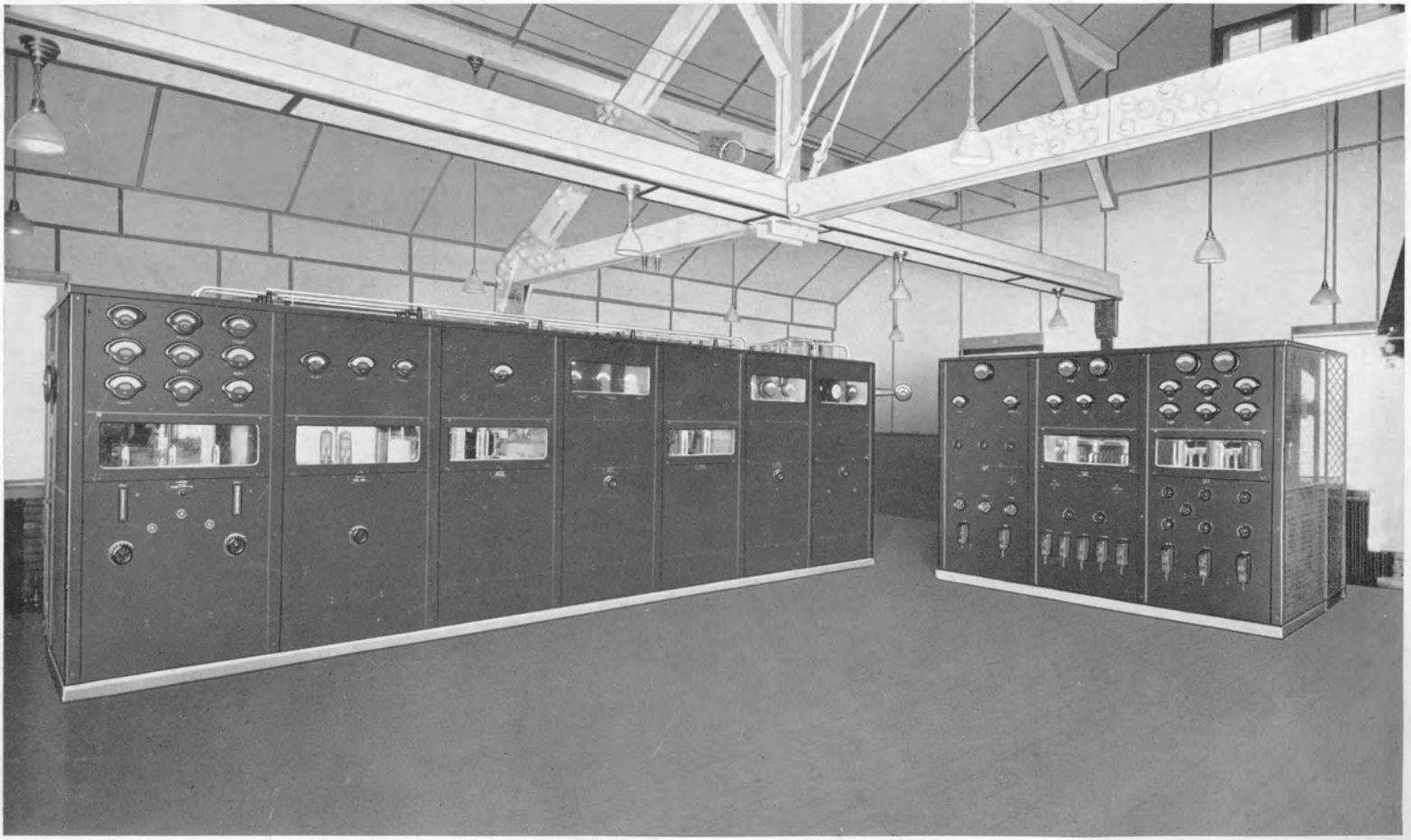

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INTRODUCTION

The importance of the transmitting station in producing broadcast programs justifies the use of the best facilities and operating technique the communication art affords. Recognition of these factors has resulted in an increasing demand for improved apparatus and methods which have been attained in the No. 7-A Radio Transmitter designed for Western Electric Company as a result of research and development carried on by Bell Telephone Laboratories, Inc.

The No. 7-A Radio Transmitter is nominally rated at 50 kilowatts. This rating is purely conventional, however, and falls short of indicating the actual performance possibilities of the transmitter, for when the carrier is modulated 100 per cent the instantaneous power delivered to the antenna is 200 kilowatts.

Another outstanding feature of this transmitter is precision of the carrier frequency. In view of the great number of stations that are now operating accurate maintenance of assigned carrier frequencies is absolutely essential. The No. 7-A equipment employs piezo-electric control by means of which the maximum deviation from assigned operating frequency can be held to well under 100 cycles.

Still another factor of importance from a regulatory standpoint is suppression of radio harmonics. In the design of this equipment, great care has been taken to insure their adequate suppression. A special arrangement is employed between the last power amplifier stage and the radio frequency transmission line which prevents the transfer of harmonic power to the latter. The line itself is balanced to ground and all apparatus is thoroughly shielded to minimize radiation.

Careful consideration has been given to the protection of the operating personnel and visitors against accidental contact with high voltage. This is not limited to a single element, but has been made doubly sure by two complete systems of protection. Briefly, the system has been arranged to make it impossible to obtain access to the apparatus without first removing the dangerous voltages. Each entrance is locked and the locks cannot be released until the control which removes the high voltages has been operated.

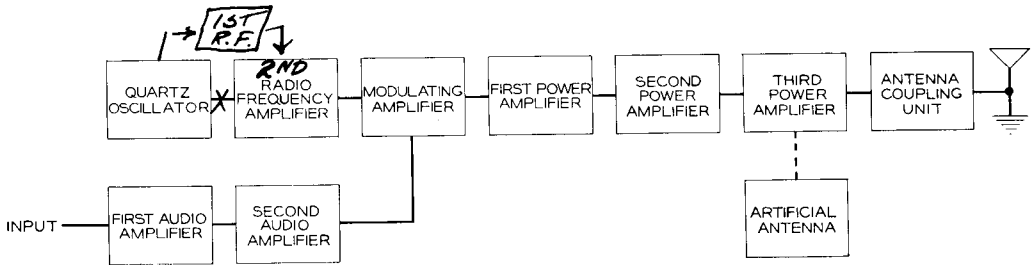
Simplicity and ease of operation are obtained by complete automatic control which takes the place of the operator in "surveying" the system to assure that everything is in order for starting, applies the power to the various circuits in

proper sequence and guards against damage to equipment from abnormal circuit conditions or by reason of a failure on the part of the operator to apply power in the proper sequence.

The following pages outline the proper methods of adjustment, operation and maintenance for the No. 7-A Radio Transmitter and describe the units of which the equipment consists and discuss the transmitter circuits.

General Features

The transmitter consists essentially of the following elements: a quartz oscillator; a low power radio frequency amplifier; a modulating amplifier connected with a two-stage audio frequency amplifier; a three-stage high power radio frequency amplifier; and the associated power supplies. These elements



Block Schematic

are combined for generating a constant frequency carrier which may be modulated by a broadcast program signal, for amplifying the modulated carrier and transmitting it to an antenna where it is radiated in the form of an electric wave.

The unmodulated carrier power which is normally supplied to the antenna from the radio transmitter is 50 kilowatts. When the carrier is modulated, this power output rises to levels in the order of 200 kilowatts during audio frequency cycles.

The transmitter can be adjusted to operate at a lower power output if so required.

Approximately 250 kilowatts at a power factor of 0.9 from a 440-volt, three-phase, 60-cycle power supply is required to operate the No. 7-A Radio Transmitter.

The transmitter is capable of working into antennas of any resistance. The antenna coupling circuits can be located at a considerable distance from the main transmitter building, thus making it possible to have the antenna structure in a space free and clear of the obstruction of the main building and at the same time remove the apparatus in the building from the intense field which immediately surrounds the antenna. These circuits are connected to the transmitter proper by a two-wire transmission line and to the antenna by a suitable lead-in.

The carrier frequency of the transmitter is controlled by a piezo-electric oscillator, the quartz crystal of which is operated at a constant temperature in order to permit accurate maintenance of frequency.

The transmitter is furnished with either of two sets of coils. One set permits operation on any carrier frequency between 500 and 1,000 kilocycles and the other set between 1,000 and 1,500 kilocycles provided a quartz oscillator, ground to the desired carrier frequency, is connected in the circuit.

The process of modulating the carrier takes place at a relatively low power level. It occurs in a 50-watt tube (Modulating Amplifier) where the modulating signal is applied to the plate circuit from that of a 250-watt tube (Audio Power Amplifier). In consequence of this arrangement, together with the large power capacity of the following amplifiers, it is possible to operate with the carrier modulated 100 per cent. The high degree of modulation produces a high sideband-to-carrier ratio and provides maximum effective transmitting range.

Radiation on harmonics of the carrier frequency is reduced to a negligible amount by the use of completely shielded transmitter circuits and by tuned circuits which suppress harmonic voltages at the input to the transmission line. With proper adjustment of these tuned circuits the power radiated at any harmonic frequency is at least 70 decibels less than the power of the fundamental.

Protection against accidental contact with high voltage circuits and apparatus by the operating personnel is provided by the control circuit arrangements and the manner in which the apparatus is assembled. The transmitter panels are dead front; that is, the panels and the apparatus mounted on them are either of insulating materials or if metal grounded.

The wire fences enclosing the rear and sides of the panel assemblies prevent access to the high voltage apparatus except through gates. These gates when opened operate control circuit switches which function to remove all high voltage from the transmitter circuits. Furthermore, power supply disconnect switches are located inside of the enclosures so that any one entering may open them insuring protection even though the gate should be closed accidently and an attempt to start the transmitter be made by another person. The high voltage cannot be applied to the circuits until these switches are closed.

The operation of the transmitter is controlled by means of circuits and relays associated with four push button control switches located on the front of two panels. The transmitter may be automatically started and stopped by means of one of these control switches; the three other switches are used when it is desired to sectionalize the starting and stopping functions of the transmitter.

Description of Apparatus

The apparatus of which the radio transmitter consists, with the exception of power and water cooling equipment, is mounted on and behind panel units which are assembled in groups as required for operation together. The power and the water cooling equipments are grouped and installed as necessary to function. The different assemblies of units are referred to as the Transmitter Unit Assembly, the Antenna Coupling Unit Assembly, the Artificial Antenna Unit Assembly, the Power Unit Assembly, the Power Equipment and the Water Cooling Equipment.

To facilitate reference to particular pieces of apparatus, each piece is designated by a combination of two letters with a numeral between them, such as, C3A. These designations are used in the instruction book and on the schematics and wiring diagrams. In the units of the transmitter these designations are marked either on the piece of apparatus itself or adjacent to it. The first letter indicates the apparatus classification. For instance, a condenser is designated by the letter "C". The number distinguishes between pieces of apparatus in the same class located in the same unit. The last letter refers to the unit according to the letter classification given in a following table. The letters designating the classification of apparatus are:

B—Bell
C—Condenser
D—Switch
F—Fuse
G—Spark Gap
H—Thermocouple
I—Indicator
L—Inductance
M—Meter
N—Heater Box
P—Protector
Q—Pressure Gauge
R—Resistance
S—Relay
T—Transformer
U—Venturi Tube
V—Vacuum Tube
W—Window Lock
X—Rectox Rectifier
Y—Water Valve

The letters assigned to the units, assemblies of units and of apparatus are:

Unit Letter	*Unit Name*
A	No. D-85486 Power Panel Unit
B	No. D-85487 Rectifier Unit
C	No. D-85488 Rectifier Unit
D	No. D-85489 Oscillator Modulator Unit
E	No. D-85490 First Power Amplifier Unit
F	No. D-85491 Second Power Amplifier Tube Unit
G	No. D-85492 Second Power Amplifier Tuning Unit
H	No. D-85493 Third Power Amplifier Tube Unit
I	No. D-85494 Third Power Amplifier Tuning Unit
J	No. D-85495 Antenna Coupling Unit
K	No. D-86650 Artificial Antenna Unit
L	Power Unit Assembly
M	Transmitter Unit Assembly
N	No. D-88357 Antenna Switching System
P	Power Equipment
W	Water-Cooling Equipment

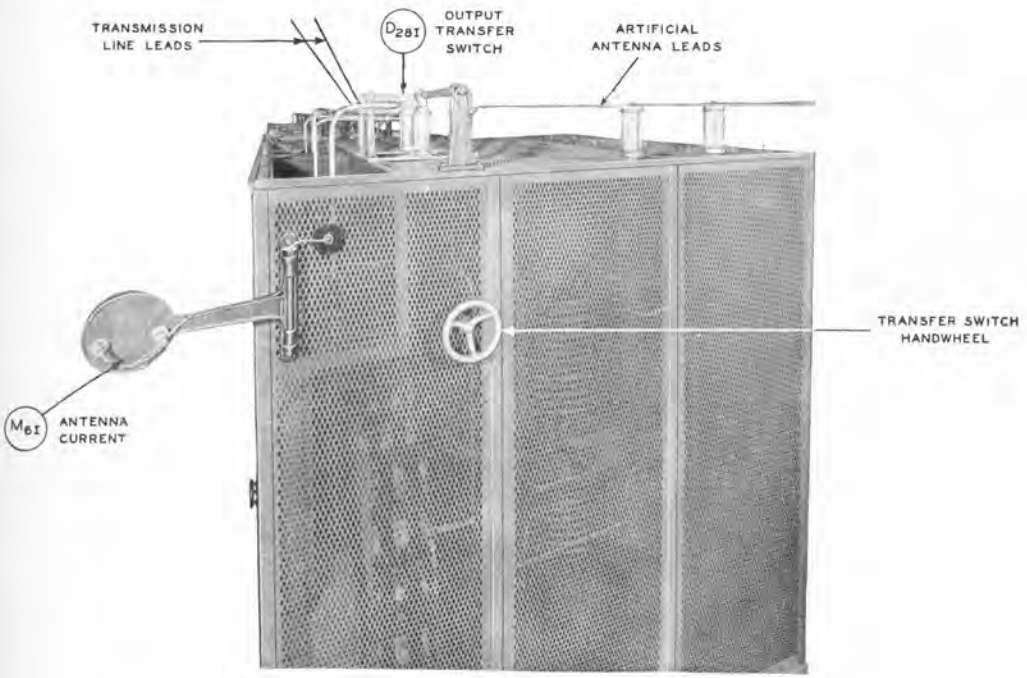
Transmitter Unit Assembly—(*See photograph below and opposite page* 1)

The units of the transmitter in which the radio frequency apparatus is assembled are grouped together and form the Transmitter Unit Assembly. These units are as follows:

No. D-85489 Oscillator Modulator Unit—(Descriptive photographs, pages 55 to 61; schematic, pages 54 and 170; wiring diagram, page 171.) The quartz oscillator, the first two stages of radio frequency amplification and the audio frequency amplifier for modulating, together with the associated apparatus required in these circuits are assembled in this unit.

No. D-85490 First Power Amplifier Unit—(Descriptive photographs, pages 63 to 67; schematic, pages 62 and 172; wiring diagram, page 173). The first power amplifier consisting of two No. 212-D Vacuum Tubes with their associated input and output circuit apparatus is assembled in this unit.

No. D-85491 Second Power Amplifier Tube Unit—(Descriptive photographs, pages 68 to 71; schematic, pages 66 and 174; wiring diagram, page 175.) Two No. 232-A Vacuum Tubes with their water jackets and cooling water hose coils, input circuit and DC plate circuit apparatus of the second power amplifier are contained in this unit.



Transmitter Assembly—Right End View

No. D-85492 Second Power Amplifier Tuning Unit—(Descriptive photographs, pages 75 to 77; schematic, pages 72 and 176; wiring diagram, page 177.) The apparatus of the tuned output circuit of the second power amplifier is mounted within a copper compartment in this unit.

No. D-85493 Third Power Amplifier Tube Unit—(Descriptive photographs, pages 78 to 81; schematic, pages 74 and 178; wiring diagram, page 179.) Six No. 232-A Vacuum Tubes with their water jackets and hose coils, together with the input circuit and DC plate circuit apparatus of the third power amplifier are assembled in this unit.

No. D-85494 Third Power Amplifier Tuning Unit—(Descriptive photographs, pages 84 to 87; schematic, pages 82 and 180; wiring diagram, pages 181 and 182.) The output circuit apparatus of the third power amplifier and the harmonic shunt circuit, together with the monitoring rectifier, are assembled and shielded by perforated sheet copper sides in this unit.

These units are mounted side by side to form the front wall of the transmitter enclosure while the sides and rear walls are made of wire mesh screening. The gate at the left side of the enclosure is equipped with mechanism operated by a handwheel which automatically disconnects the power from the transmitter and grounds the high voltage circuits before the gate can be opened.

No. D-85495 Antenna Coupling Unit Assembly—(Descriptive photographs, pages 89 to 91; schematic, pages 88 and 184; wiring diagram, page 185.) The primary and secondary tuned circuit apparatus for coupling to the antenna is assembled into a unit which is completely shielded by perforated sheet copper. The unit enclosure is partitioned into two compartments. The primary tuning coil is placed in one compartment and the antenna loading coil is placed in the other.

No. D-86650 Artificial Antenna Unit Assembly—(Descriptive photographs, page 94; schematic, pages 92 and 186; wiring diagram, page 381.) The apparatus forming the Artificial Antenna Unit is assembled inside of a perforated sheet copper enclosure which functions to shield this apparatus.

Power Unit Assembly—(*See photograph page* 47.)

The following are the units which are grouped together to form the Power Unit Assembly:

No. D-85486 Power Panel Unit—(Descriptive photographs, pages 35 to 39; schematic, pages 34 and 160; wiring diagram, page 161.) The power supply circuit, the power control circuit, the filament control circuit and the grid voltage circuit together with the associated switch and relay equipment are assembled in this unit.

No. D-85487 Rectifier Unit—(Descriptive photographs, pages 43 to 46; schematic, pages 42 and 164; wiring diagram, page 165.) The transformers, tubes and filtering apparatus of the 1,600-volt rectifier are assembled complete in this unit.

No. D-85488 Rectifier Unit—(Descriptive photographs, pages 49 to 51; schematic, pages 48 and 166; wiring diagram, page 167.) The 17,000-volt rectifier tubes, tube sockets and meters are assembled in this unit. The associated transformers and filter equipment is usually located in a room directly below the unit.

The two sides and rear of the assembly are closed by a wire mesh fence, a gate to the enclosure being located on the left-hand side. A handwheel to the right of the gate operates the bolt which locks the gate. It also operates switches which remove the power and ground the 1,600-volt and 17,000-volt circuits before the gate can be opened.

Water Cooling Equipment—(*Descriptive photograph, page* 97; *schematic, pages* 96 *and* 188.)

The water-cooled tubes differ in construction from the more familiar radiation-cooled tubes, the plate or anode being of copper, cylindrical in form and closed at one end. The other end is welded to a glass bulb so that the tube envelope consists partly of the anode itself. Within it are the grid and the filament, to which leads are brought in through the glass enclosed end of the tube.

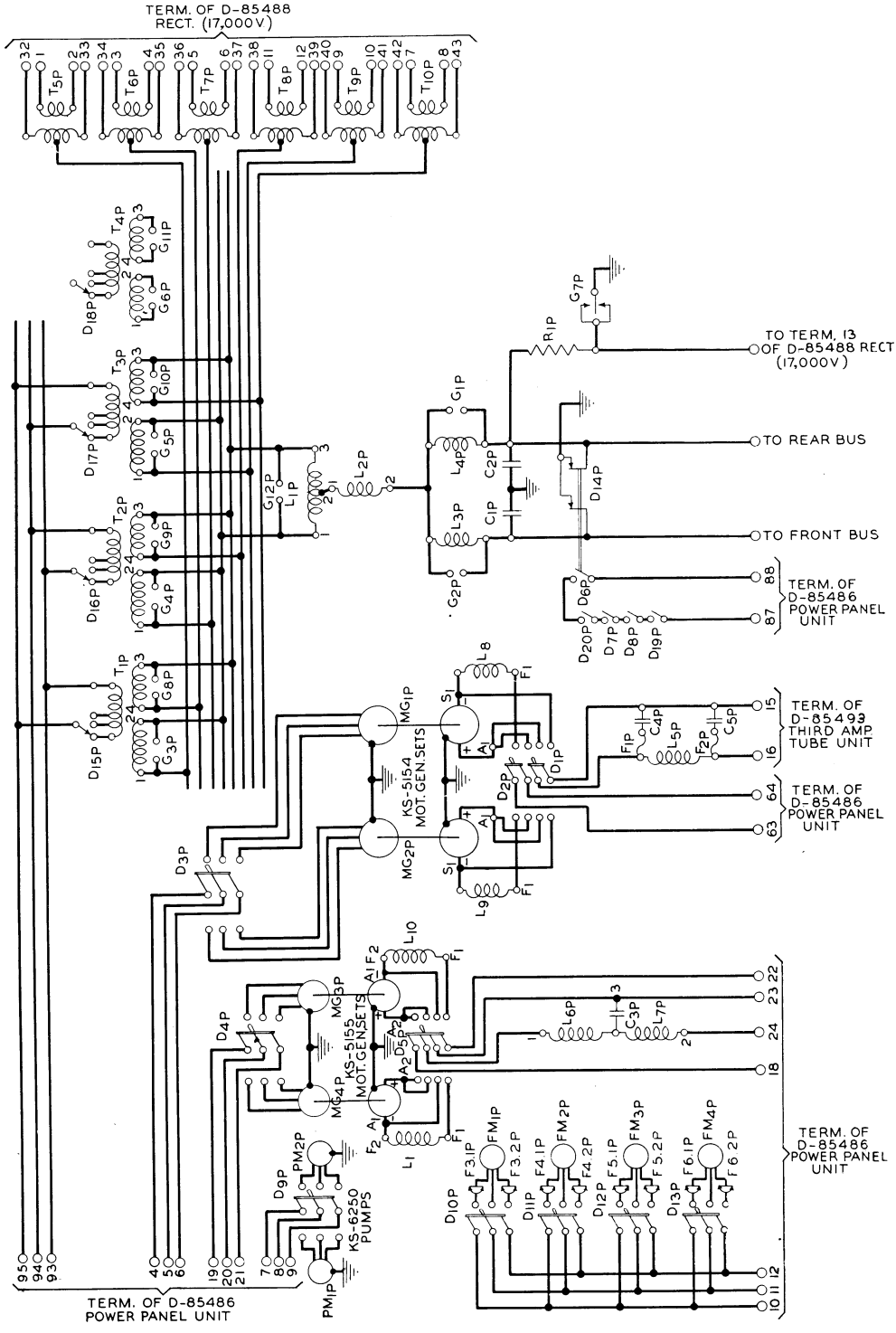
In use, the tubular anode is inserted and clamped in a water jacket through which the cooling water circulates. Through its water jacket the anode is also connected electrically to the plate circuit.

In the No. 7-A Radio Transmitter a total of fourteen tubes are water-cooled. Six of these tubes are rectifiers used for providing plate current to the other eight which are used in the last two stages of amplification. Heat is generated in the vacuum tubes by the power dissipated from the filaments and by that lost at the anodes due to the flow of plate current. The total heat thus generated in the fourteen tubes is transferred to the cooling water from the anode surfaces. The water jackets are so constructed that a thin cylindrical sheet of water passes over each anode surface at a high velocity, thus permitting a large part of the heat to be transferred to the water by direct contact. Continuous flow of water is essential for the removal of the heat even from the filaments alone.

The anodes and water jackets of the amplifier tubes are at a potential of 17,000 volts above ground. To restrict the leakage of current from the jackets to the grounded pipes of the cooling system, the two are connected through lengths of coiled rubber hose so that there are interposed columns of water long enough to make a high electrical resistance to ground.

The water jackets and anodes of the rectifier tubes are practically at ground potential so that water connections to the supply pipe can be made by using short lengths of hose.

The water is cooled in four large radiators through which air is forced by motor-driven fans. The water circulating pump and the fans are stopped and started automatically with the transmitter.

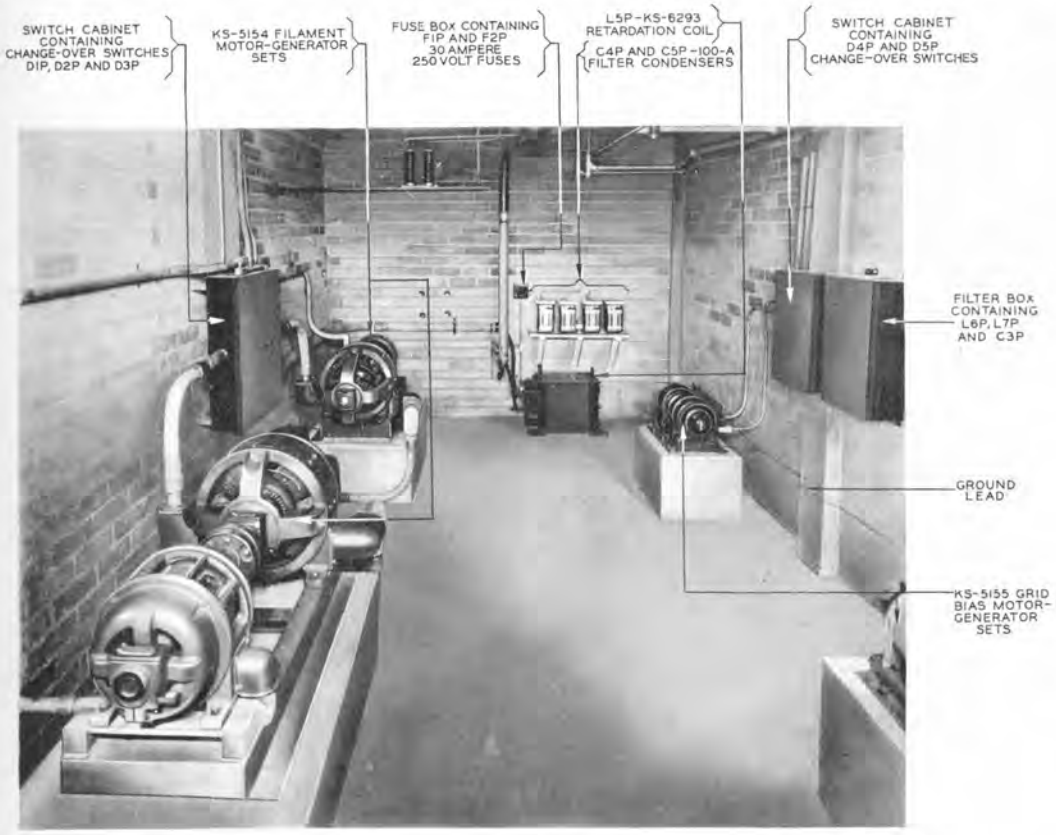


Schematic of Power Apparatus

The use of ordinary water with its probable high mineral content invariably leads to serious trouble through the formation of scale on the anodes of the tubes, and as the electrical resistance of such water is low, rapid electrolytic disintegration of the hose nipples is encountered. To avoid or minimize these effects, it is desirable to use distilled water in the circulating system.

Because the amount of dissipated energy differs in the various groups of tubes, each group must receive a proportional amount of water flow. The hydraulic resistance of each of the paths through which the water flows from the pump to the radiators is therefore designed to give the necessary proportion. The total flow of water is from 90 to 100 gallons per minute.

For the purpose of providing automatic protection against the dangerous effects of overheating in case of an interruption of water flow, each branch of the hydraulic network contains a Venturi tube whose inlet and throat orifices are connected to a device containing two opposed metallic bellows. These bellows are operated by the difference in pressure established between the orifices by the flowing water; when the flow is normal the device closes an electrical contact in the power control circuit. If the flow is interrupted or if it falls to 70 per cent of normal, the bellows at once function to open relays which remove the



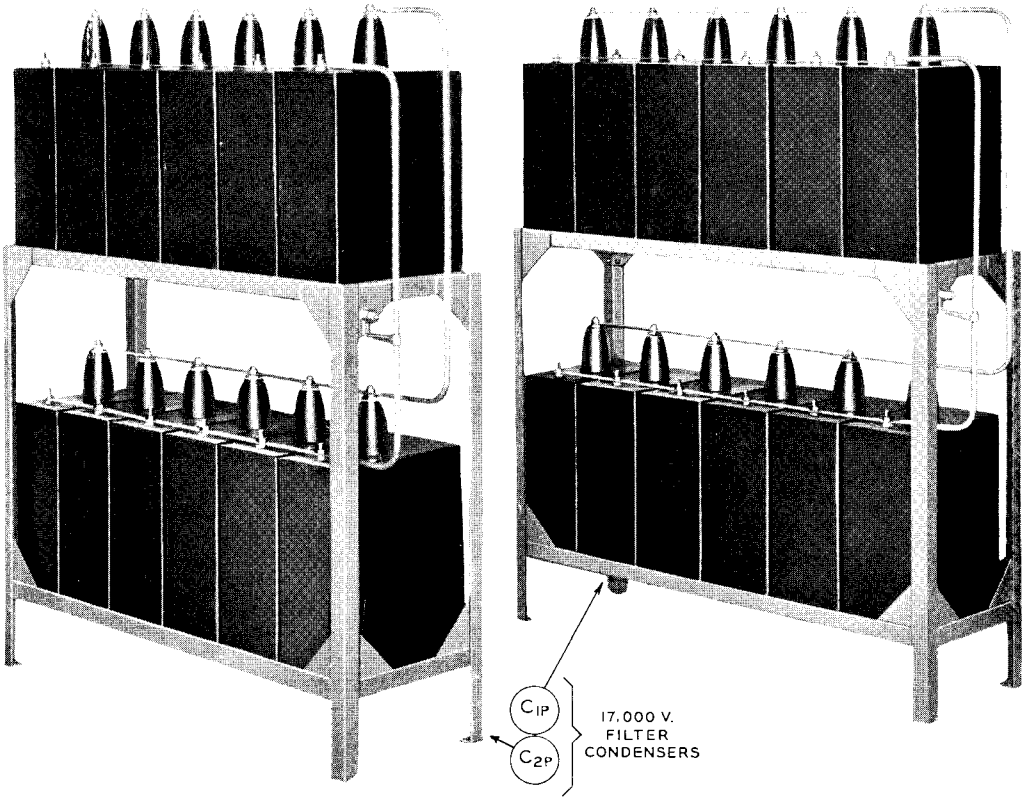
Generator Room

filament and plate power. Two contact-making thermometers are provided indicating respectively the temperatures of the water as it enters and leaves the jackets. The contacts of one thermometer close an alarm circuit if the inlet water temperature rises above a certain value; those of the other thermometer short circuit a control relay if the temperature rises above a higher value, removing the plate and filament voltages. A pressure gauge is located on the power panel to indicate whether the pump is operating properly.

After the distilled water is used for a considerable period of time, it may absorb enough impurities to lower its resistance considerably. For that reason a milliammeter is provided which indicates the magnitude of the current leaking through one of the hose coils when the equipment is in operation, thereby indicating when it is advisable to change the water.

Power Equipment—(*Descriptive photographs, page* 9 *and below; schematic, pages* 8 *and* 147.)

The two filament motor-generator sets, the two grid bias motor-generator sets, the motor-generator change-over switch cabinets, the filament circuit filter, the grid circuit filter and the 17,000-volt rectifier transformers and filters are referred to as the Power Equipment. This apparatus is usually placed on the floor below the operating room.



17,000-*Volt Filter Condensers*

Description of Circuits

The description of the circuit of the No. 7-A Radio Transmitter is taken up through the process of analyzing the circuit into its component parts such as the power circuit, the control circuit, the filament circuit, etc. These component circuits usually extend through several of the Transmitter Units. The identification of a particular part of a circuit and its association with a particular unit is readily made by the apparatus designation.

Although the schematic and wiring diagrams of the different units are not described individually, they are grouped together at the end of the text for reference. In addition some of the diagrams are supplied in the form of large folded sheets.

Power Circuit

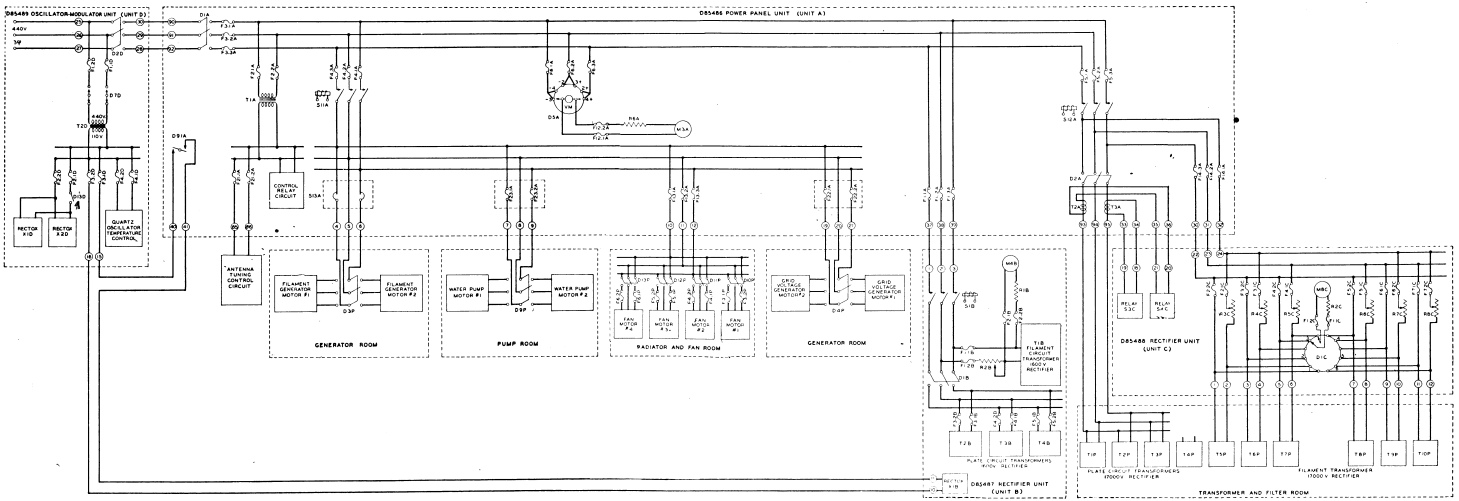
Distribution of Primary Power Through the Units

A simplified schematic showing the distribution of the primary power throughout the transmitter units is shown on pages 12 and 148. The main power service connection is usually made to the transmitter through a service disconnect switch located elsewhere in the building. The power circuit goes through the switch D2D in the Oscillator Modulator Unit to switch D1A in the Power Panel Unit where it is connected to the main power circuits of the transmitter. These two switches, D2D and D1A, are provided as safety disconnect switches which may be opened upon entering the enclosures, disconnecting all of the circuits in the transmitter, with the exception of one, from the main power supply. The circuit to which the exception is made is the branch in the Oscillator Modulator Unit connected to one phase of the power supply on the line side of switch D2D. This branch circuit is used to furnish power to the temperature control apparatus for the quartz oscillators and to the Rectox units operating the electric window openers.

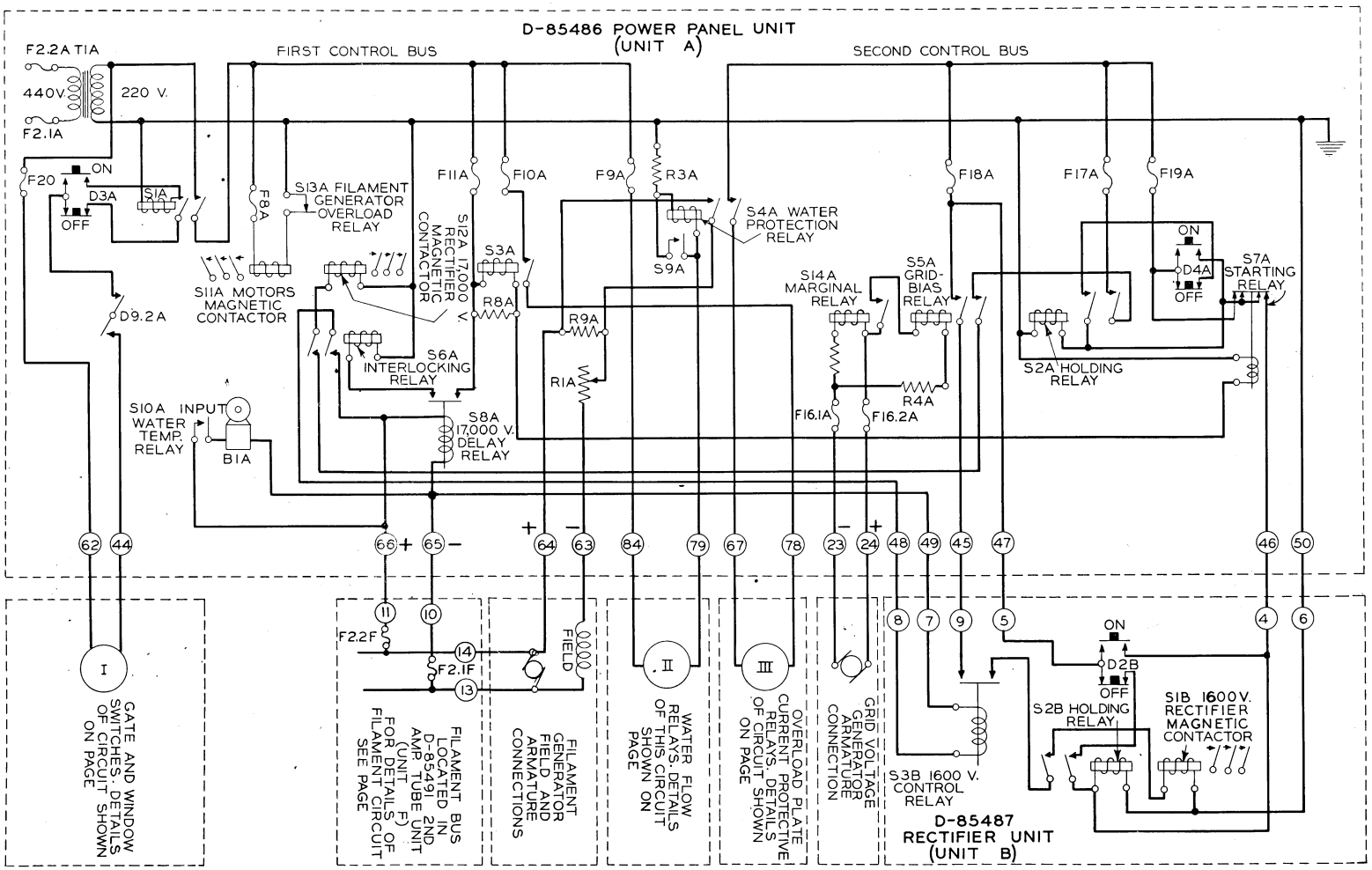
The power circuit has four branches in the Power Panel Unit; the first branch is connected from one phase of the power circuit to the control relay circuit and to the antenna tuning control circuit; the second branch is connected to the motors of the transmitter; the third branch is connected to the apparatus in the 1,600-Volt Rectifier Unit; and the fourth branch is connected to the apparatus of the 17,000-Volt Rectifier Unit.

The circuit to the motors passes through a magnetic contactor, S11A, which is used to switch all of the motors on or off the power supply simultaneously and which is operated by the control circuit shown on pages 13 and 149. All motors are protected by means of temperature relays or thermal cut-outs from overloads occurring over periods of time long enough to endanger the motors.

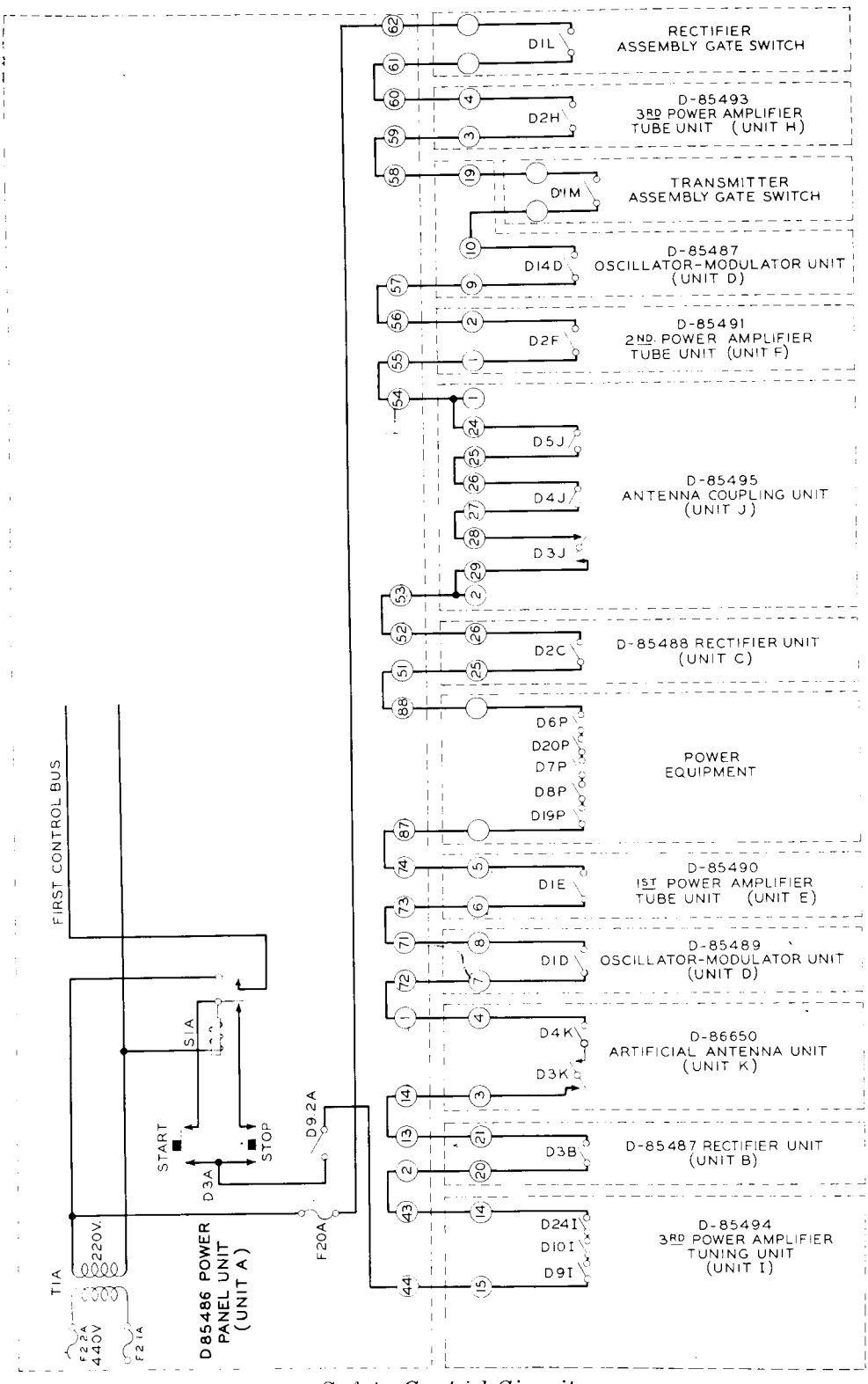
The power supply to the 1,600-volt rectifier passes through magnetic contactor, S1B, which is operated by means of the power control circuit shown on pages 13 and 149 and through a disconnect switch, D1B, which may be opened if it is desired to light the filaments of the 1,600-volt rectifier tubes without applying plate voltage.



Distribution of Primary Power (*See also large diagram in envelope*)



Power Control Circuit



Safety Control Circuit

The power supply to the 17,000-volt Rectifier is similarly connected through magnetic contactor, S12A, operated by means of the power control circuit and through disconnect switch, D2A, which provides means for disconnecting the voltage from the plates of the 17,000-volt rectifier tubes. Current transformers, T2A and T3A, provide overload protection for 17,000-volt transformers. They are connected [redacted] to the windings of relays S3C and S4C, whose contacts are connected in the power control circuit.

The first branch from the power supply circuit in the Power Panel Unit is connected to the antenna tuning control circuit and to the power control circuit by means of transformer T1A which steps down the line voltage from 440 to 220 volts. The antenna tuning control apparatus is located in the Third Power Amplifier Tuning Unit and in the Antenna Coupling Unit.

CONTROL CIRCUITS

Operating control of the transmitter is obtained through a system of control switches and relays. The control can be sectionalized for the purpose of allowing adjustments to be made or it can be arranged to cause the complete transmitter to be placed in operation by the use of a single switch which is called the "MASTER CONTROL" switch.

Power Control Circuit.

From the 440-volt power source the following other forms of power are obtained which are controlled in the proper sequence of application to the radio transmitter circuits:

20 volts DC for filament heating of all the amplifier vacuum tubes; obtained from a generator.

1,600-volt DC plate voltage for the radiation cooled tubes; obtained from a rectifier.

17,000-volt DC plate voltage for the water cooled vacuum tubes; obtained from a rectifier.

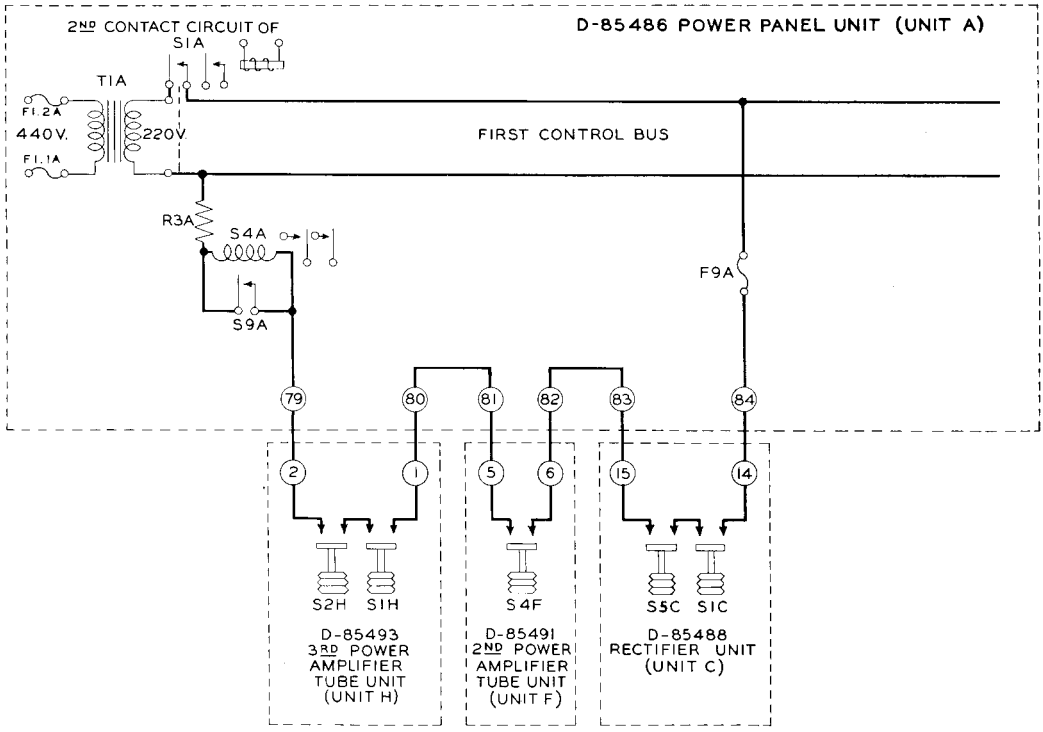
300-volt DC supply for the grid bias voltage of all vacuum tubes; obtained from a generator.

(Power is supplied at 440 volts to the water circulating pump and the radiator fans.)

The 440-volt power supplied to the various components of the power equipment is controlled by magnetic contactors. These contactors are operated by means of relays which are in turn controlled by momentary contact push button switches. This arrangement of contactors, relays, and switches, together with the circuits connecting them, is referred to as the Power Control Circuit.

A simplified diagram of the Power Control Circuit will be found on pages 13 and 149. As indicated on the drawing this circuit extends through several units, however, the major portion of it is contained in the Power Panel and 1,600-Volt Rectifier Units.

On pages 13 and 149 the control circuit buses are shown at the top of the figure. The transmitter may be started or stopped by the "MASTER CONTROL SWITCH" D3A. When the "ON" button of this switch is pressed S1A operates and voltage is applied to the first control bus through the contacts of S1A provided the gate and window switches are closed. (See diagram pages 14 and 150). S1A locks up its contacts by the circuit through its first set of contacts and the "OFF" contacts of D3A. S1A can be released by pressing the "OFF" button of D3A



Water Flow Protection Control Circuit

or by opening any one of the safety switches. The release of S1A stops the transmitter. With voltage applied to the first control bus, power is supplied to the motor magnetic contactor, S11A, the second control bus relay, S3A, and the starting relay S7A.

Time delay relays S8A, S7A and S3B are of the type in which the armature of the relay is drawn into the solenoid when the latter is energized. This is indicated schematically in the circuit diagram by indicating that the moving contact of the relay is raised when the winding of the circuit of the relay is energized.

When S11A operates (see diagram on pages 12 and 148) power is supplied to the following motors:

Radiator Fan Motors.
Pump Motor.
Filament Voltage Generator Motor.
Grid Voltage Generator Motor.

The flow of cooling water through the power tube jackets starts as soon as the pump motor operates.

The circuit of S11A is closed through the overload relay S13A. If the motor driving the filament generator is overloaded, thus drawing an excessive current for an extended time, this relay will open, releasing S11A.

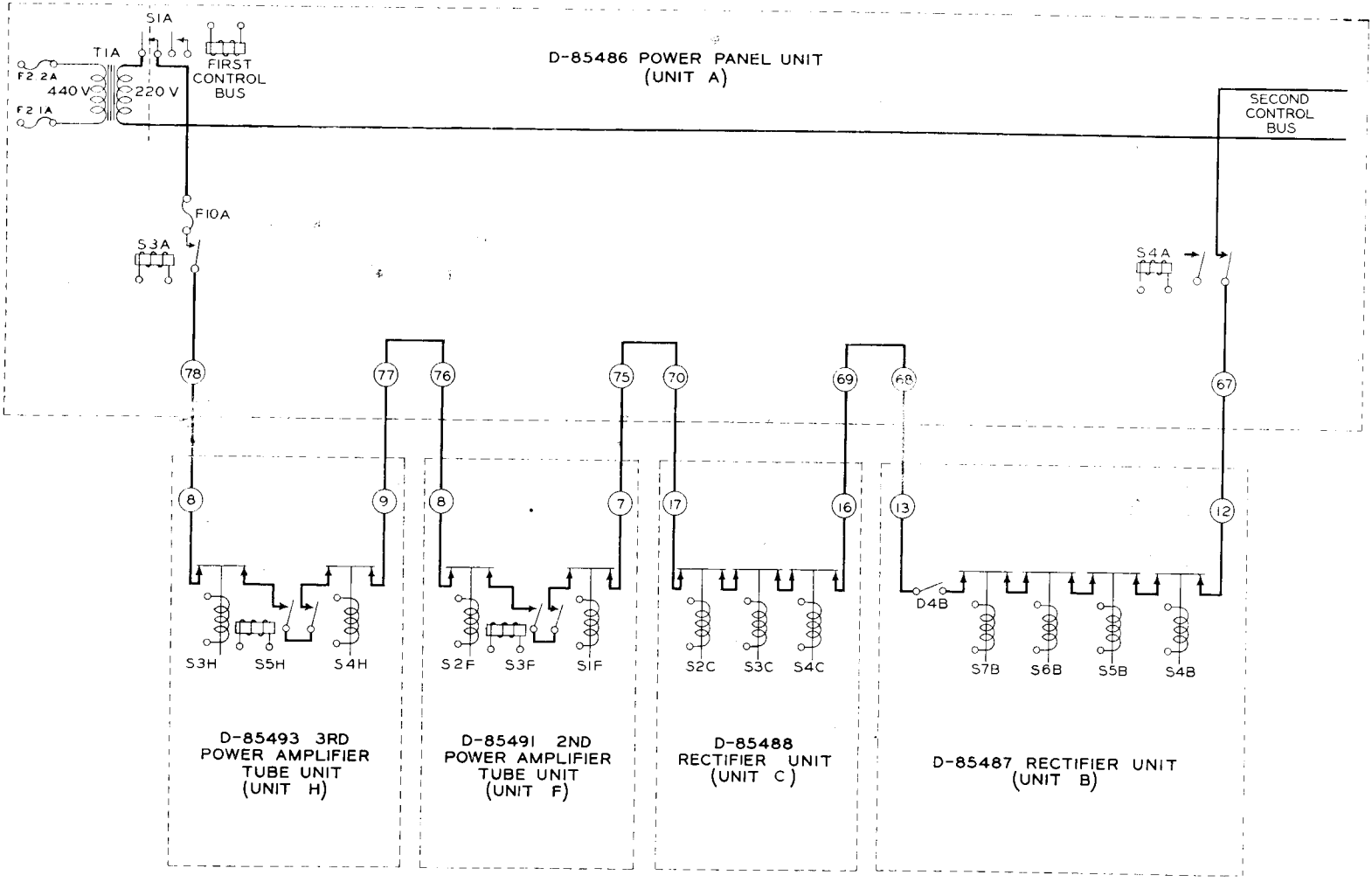
Relay S7A is energized when the circuit to the first control bus is closed but the opening of its contacts is delayed 20 seconds. In this time interval the pump and the filament generator will start, thus closing the contacts of the water flow relays (designated as II in the diagram pages 13 and 149 and detailed in the diagram pages 16 and 151) and of the filament circuit relay (S5H and S3F shown in the diagram on pages 18 and 152). These filament circuit relays are in series with several overload relays as shown on pages 18 and 152, the whole combination being designated by III in the diagram on pages 13 and 149. Relay S4A will operate when relay chain II is complete; the second control bus will be energized when relay chain III is complete.

The windings of S7A and S3A are in series to guard against the possible difficulty of an open circuit in S7A. If S3A was not in the circuit and if S7A did not operate, due to an open circuit in its winding, the plate voltage could not be controlled by pushing the buttons of the switches D2B and D4A, as the contact circuits of S7A would continue to short the "ON" contact circuits of these switches.

The water protection relay S4A is energized from the first control bus through the water flow relays which are closed when the proper quantity of water is passing through the vacuum tube jackets. When the flow of the cooling water is reduced below the safe minimum value, the relay contacts open. When S4A operates, one pair of its contacts short circuits resistance R9A which is in series with the field circuit of the filament generator. This allows the filament voltage to rise to its normal value whereupon the filament circuit relays S3F and S5H (pages 18 and 152) in the Second and Third Power Amplifier Tube Units will operate and in the case of automatic starting the operation of these relays will connect the second control bus to the first control bus. Should the temperature of the cooling water from the outlet of the vacuum tube jackets rise above 165 degrees F. the winding of S4A will be short-circuited by the contacts of the outlet cooling water thermometer relay S9A. If this short circuit occurs the contacts of S4A open, opening the field circuit of the filament generator and the circuit to the second control bus. The opening of the contacts of any of the water flow relays or the closing of the contact of S9A removes the plate voltage from all tubes of the transmitter, as the plate voltage power control switches are energized from the second control bus.

The inlet cooling water thermometer relay S10A operates when the temperature of the cooling water to the inlet of the water jackets of the vacuum tubes rises to a temperature of 150 degrees F. If the contacts of S10A close, bell B1A, connected across the filament generator circuit, will ring.

Time delay relay S8A is energized by the filament voltage which builds up after the contacts of S4A close. The operation of S8A is delayed 20 seconds after



Tube Protection Control Circuit

it is energized. In this time interval the filaments of the vacuum tubes will be heated to their normal operating temperature.

The interlocking relay S6A is energized from the first control bus when S8A operates and the 1,600-volt control relay S3B is energized by the filament voltage when S6A operates. Through means of S6A and S3B interlocking control between the application of the filament and plate voltages is obtained. When S14A operates, it causes S5A to be energized by the grid bias voltage. Through the means of S14A and S5A interlocking control between the application of the grid and the plate voltages is obtained.

The "SECOND CONTROL BUS" supplies power to the following relays after S2B and S2A have operated and locked their contacts by means of the holding circuit through the "OFF" contacts of D2B and D4A:

S2B—Holding Relay, associated with the 1,600-volt rectifier control switch D2B.

S2A—Holding Relay, associated with the 17,000-volt rectifier control switch D4A.

S1B—Magnetic contactor controlling the 440-volt power circuit to the 1,600-volt rectifier.

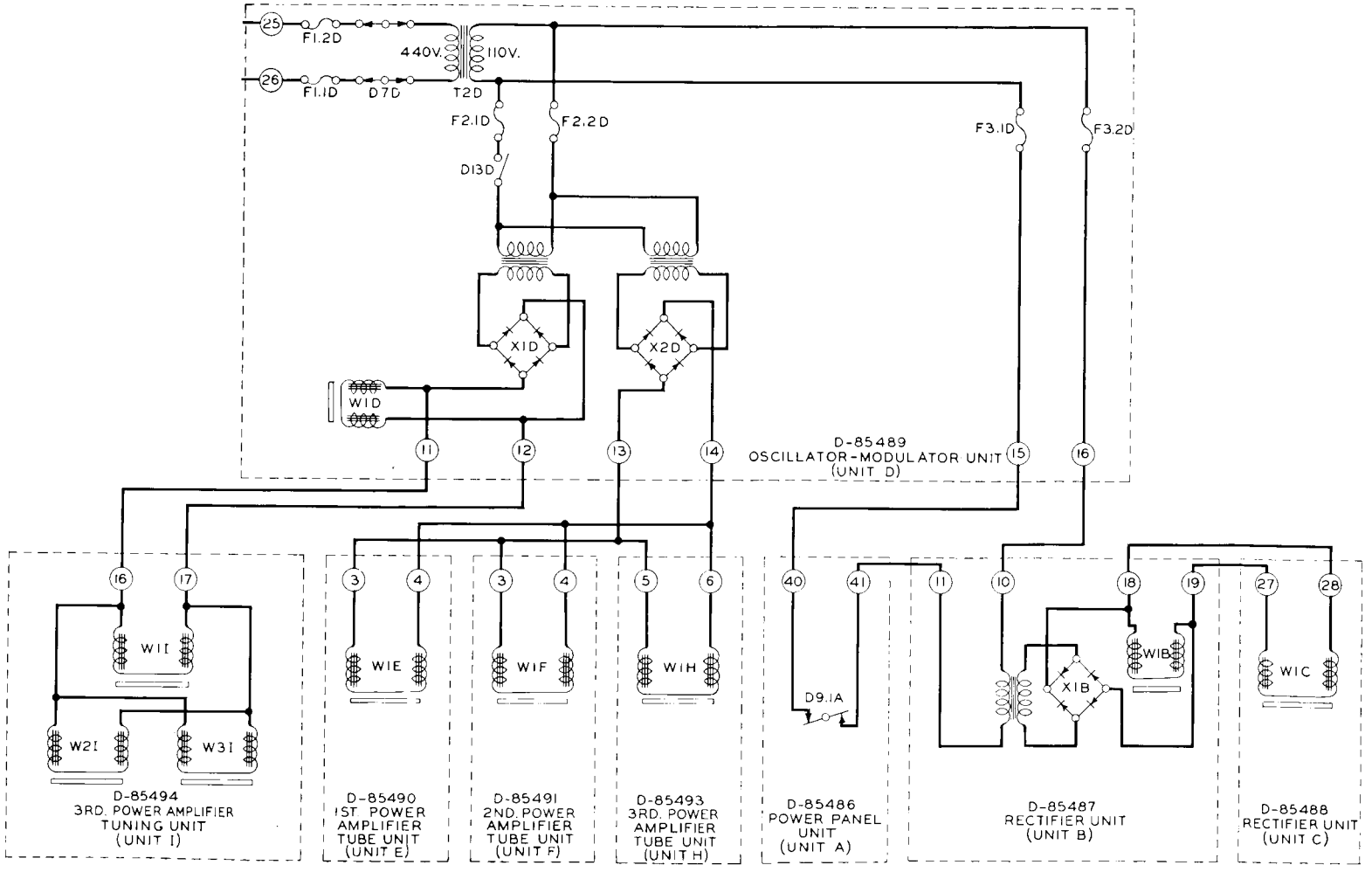
S12A—Magnetic contactor controlling the 440-volt power circuit to the 17,000-volt rectifier.

Therefore, as soon as the contacts of S6A, S3B and S5A close, S1B and S12A will operate closing the 440-volt power circuit to the rectifier units.

After S7A has operated opening its contacts, switches D2B and D4A may be used to control application of the plate voltages separately. Automatic starting of the transmitter circuits may be prevented by pressing the "OFF" button of the "RECTIFIER CONTROL" switch D4B (thus opening chain III shown in the diagram on pages 13 and 149) before pressing the "ON" button of the "MASTER CONTROL" switch D3A. After S7A has operated the "ON" button of D4B may be pressed and then the 1,600-volt and the 17,000-volt rectifiers may be operated separately by means of D2B and D4A, respectively.

If the main 440-volt power supply should fail, voltage is removed from the control bus and all of the control relays will be released and the contacts of the master control relay S1A will be opened. The reapplication of 440-volt power supply will not cause the closing of the contacts of S1A until "ON" button of the "MASTER CONTROL" switch D3A has been pressed.

If the transmitter is in operation and a gate or window is opened the same control action takes place. The opening of a gate or window opens the holding circuit of S1A (pages 14 and 150). This action removes the voltage from the first and second buses in the manner described previously. If the transmitter is in operation and any one of the overload relays should operate the power to the second control bus is cut off causing the holding relays S2B and S2A to release (pages 13 and 149). This in turn causes the magnet contactors S1B and S12A to be de-energized, removing the plate voltage from all



Door and Window Switch Control Circuit

vacuum tubes. If the cooling water flow should cease or if the water temperature should become greater than 165 degrees F. the circuit of the second control bus is opened by relay S4A (see pages 13 and 149). This will also cause the plate voltage to be removed from all vacuum tubes in the transmitter. The field circuit of the filament generator is also opened by the second contact circuit of the relay S4A thus removing voltage from all filament circuits in the transmitter. This control operation causes the interlocking relays S8A, S3B, and S6A to release. When the water flow is restored or the temperature is reduced below 165 degrees F. the filament voltage is automatically applied and the starting of the transmitter is completed automatically if D1B is closed. If the filament generator should cease to generate for any reason a similar control action occurs. The interlocking relays S8A, S6A and S3B will release and open the circuits of the magnetic switches S1B and S12A thus removing the plate voltage from all vacuum tubes.

If the voltage of the grid bias generator should drop to a value less than 220 volts the contacts of S14A will open, which in turn open the circuit of S5A. When the contacts of S5A release the circuits of the magnetic switches S1B and S12A are opened, and the plate voltage for all vacuum tubes in the transmitter is removed.

When it is desired to stop the transmitter by means of the "MASTER CONTROL" switch D3A the following action takes place: When the "OFF" button of D3A is pressed, the holding circuit of S1A is opened. This causes S1A to release removing the voltage from the first and second control buses thus causing all the relays to be de-energized in the following sequence.

1. The magnetic switches S11A, S1B and S12A will open immediately removing their respective loads from the 440-volt power circuit. Relays S2A, S3A, S4A, S6A, S7A and S2B will also release immediately.

2. Relays S8A, S3B, S3F and S5H energized by the filament voltage will release when the voltage drops as the speed of the filament generator decreases.

3. Relays S14A and S5A energized by the grid voltage will release when the voltage drops to 220 volts as the speed of the grid generator decreases.

Protection for the operating personnel is provided in the control circuits to prevent contact with the high voltage circuits. This protection is not limited to a single protective element, but it has been made doubly sure by employing two systems of protection. The system has been arranged not only to make it impossible to obtain access to the apparatus through the normal entrances without first removing the plate and filament voltages on all tubes before an entrance may be opened, but each entrance is locked and these locks cannot be released until the control which removes the plate and filament voltages has been operated. These two protective features are combined at the gate entrances of the apparatus enclosures in a protective device which is referred to as a safety wheel. The protective elements used to remove the plate and filament voltages are referred to as gate and window switches and the protective elements used to lock the window entrances are referred to as window locks.

A safety handwheel is mounted adjacent to the entrance gate of the following assembly enclosures:

Antenna Coupling Unit Assembly (J)
Artificial Antenna Unit Assembly (K)
Power Unit Assembly (L)
Transmitter Unit Assembly (M)
Transformer and Filter Room (P)

Rotating a safety handwheel to the protection position performs the following functions:

It opens a switch in series with the winding of the master control relay S1A shown on pages 14 and 150. This stops the transmitter or prevents it from being started and grounds the high voltage circuits within the enclosure.

It causes the window and door locks (see pages 20 and 153) in the units associated with that enclosure to be energized from a Rectox unit, thus unlocking the panel doors and windows. The Transformer and Filter Room (P), the Artificial Antenna Unit Assembly (K) and the Antenna Coupling Unit Assembly (J) have no windows so the handwheels associated with them are not provided with contacts to operate window locks as in the case of the handwheel associated with the other units. They remove the power, unlock the gates and ground the high voltage leads within those enclosures.

Filament-Voltage Control Circuit

The filament voltage energizes relays S8A, S3B (see pages 30 and 157), S3F and S5H (see pages 18 and 152). Before the voltage can build up and operate these relays the water-flow relays and S4A must operate; when the latter relay closes the filament generator field circuit is closed and the filament voltage rises. The application of the plate voltages is dependent upon the operation of all the relays energized by the filament voltage.

Water-Flow Protection Circuit.

A simplified circuit diagram is shown on pages 16 and 151. S2H, S1H, S4F, S5C and S1C are water-flow relays operated by the differential pressure produced by the flow of cooling water through a Venturi tube. The contacts of these relays close only when the flow of cooling water exceeds a certain minimum value. The filament voltage builds up after the contacts of all these relays close and cause S4A to operate. The contacts of S9A which short circuit the winding of S4A are operated by the outlet water thermometer when the temperature of the cooling water from the outlets of the tube jackets exceeds 165 degrees F.

Grid-Voltage Control Circuit

S14A (pages 13 and 149) is a marginal relay which operates when the grid voltage builds up to 280 volts and releases when the grid voltage drops to 220 volts. S5A operates after the contacts of S14A close. The application of both the 1,600-volt and 17,000-volt plate voltages is dependent on the operation of these two relays.

Plate-Voltage Control Circuit

This circuit connects the first control bus to the second control bus through a chain of overload relays III in the diagram on pages 13 and 149. When this circuit is opened both the 1,600-volt and the 17,000-volt rectifiers are disconnected from the 440-volt power supply.

The contacts of the overload relays S3H, S4H, S2F, S1F, S3C, S4C, S4B, S5B, S6B and S7B on pages 40 and 163 are closed normally but they open when the relays operate on overloads. The contacts of the filament circuit relays S3F and S5H shown on pages 30 and 157 close only when the filament voltage is applied to the filament buses in the Second and Third Power Amplifier Tube Units. D4B is closed or opened manually depending on whether automatic application of the plate voltages is or is not desired. The contacts of S3A and S4A are operated in the normal control procedure as explained in the general description.

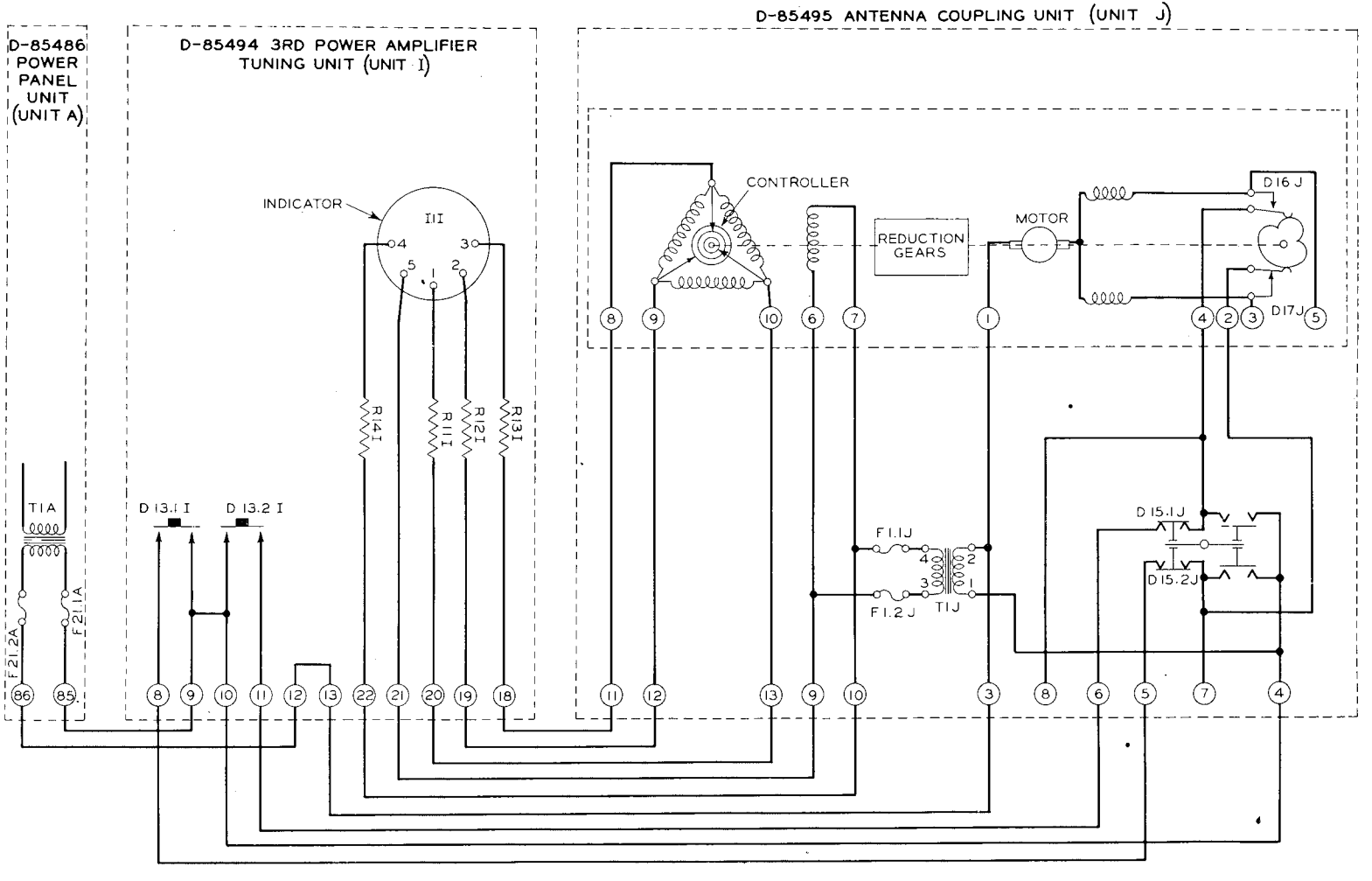
Door and Window-Switch Control Circuit

D3A and the chain of door and window switches (pages 14 and 150) must be closed before S1A can operate. It should be noted that the door and window-switch circuit in each unit is brought back to a pair of terminals in the Power Panel Unit. This arrangement of the circuit makes it possible to test at the power panel terminal strip the circuits through the various units. The panel windows and doors in the various units are equipped with both a switch and a lock with an electric lock opener. The lock openers shown on pages 20 and 153 consist of an electro-magnet arranged to draw back the latch when it is energized. The lock openers are energized by a DC voltage obtained from Rectox units connected to the AC power supply. Power to this circuit is controlled by D7D. The lock openers in the Transmitter Unit Assembly and the Power Unit Assembly are controlled independently by the switches D13D and D9.1A which are operated by the handwheels at the entrance to these assemblies. The handwheels at the same time open D14D and D9.2A and ground the plate voltage circuits through D9D, D11D, D12D in the Transmitter Unit Assembly and through D5B, D3C in the Power Unit Assembly so that the transmitter is stopped and the plate circuits grounded before the windows or panel doors can be opened.

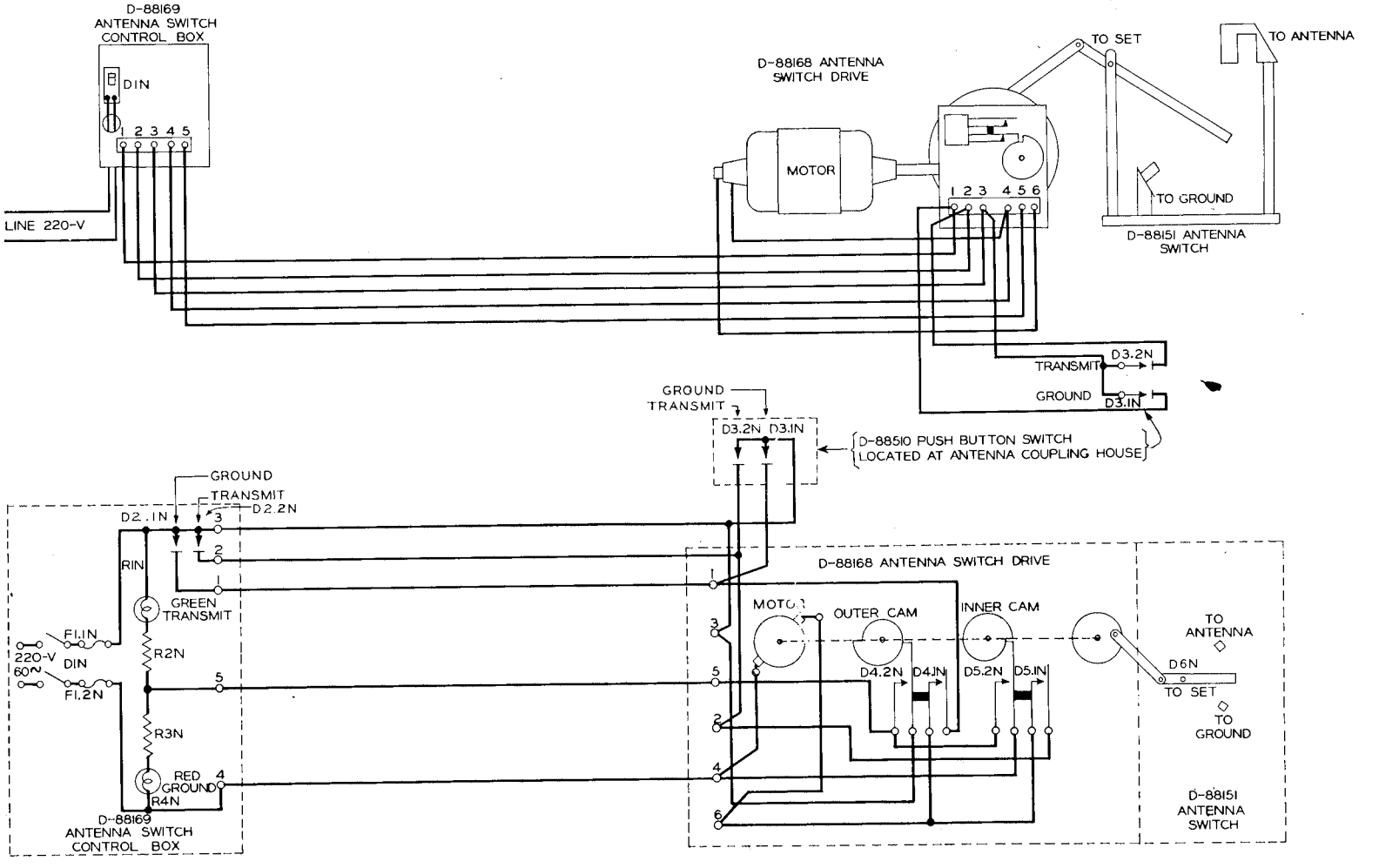
Antenna-Tuning Control and Indicator Circuit

This circuit shown on pages 24 and 154 is arranged for remote and local control of the motor used to turn the closed ring in the antenna tuning coil L3J and to obtain an indication at the transmitter of the angular position of the ring through means of a controller driven by the motor and the indicator instrument I1I.

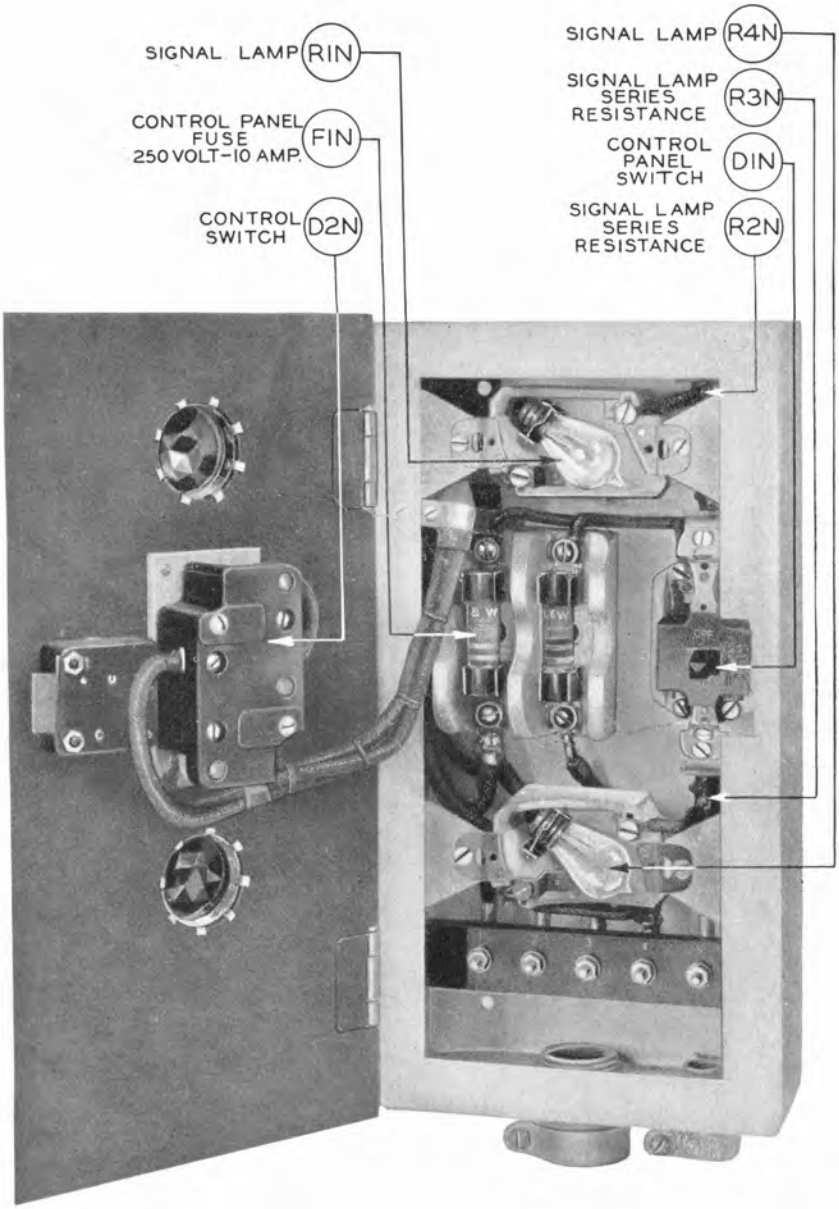
The starting, the stopping and the direction of rotation of the motor is controlled by means of either switch D13I or switch D15J. The contacts of D13I are in series with the left hand set of contacts of D15J so that it is not possible to close the control circuit at D13I in opposition to the control of D15J if either set of its right contacts is closed.



Antenna Tuning Control and Indicator Circuit



Wiring Diagram and Schematic of No. D-88357 Antenna Switching System

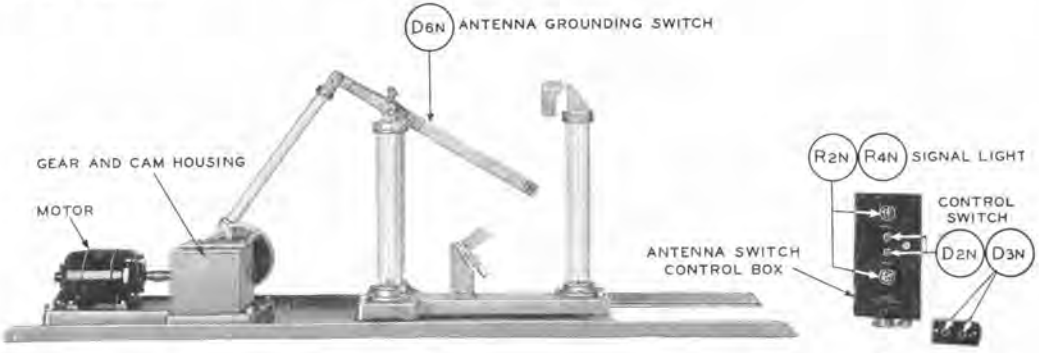


No. D-88169 Antenna Switch Control Box—Open View

The direction of rotation of the motor is controlled by closing the motor circuit through one or the other of the field windings. The field circuits are in series with the switches D16J and D17J which are operated by a cam geared to the motor. The shape and position of the cam is such that the field circuit is opened when the closed ring is 5 degrees beyond either a vertical or a horizontal position. Thus these switches limit the total angular movement of the ring to 100 degrees. The angular position and movement of the closed ring is indicated at the Third Power Amplifier Tuning Unit by means of the indicator instrument I/I.

Antenna Grounding Switch Control Circuit

Both the wiring and schematic diagrams of this circuit are shown on pages 25 and 155. This circuit controls the motor which operates the antenna grounding switch D6N and it indicates the position of the switch by means of signal lights.

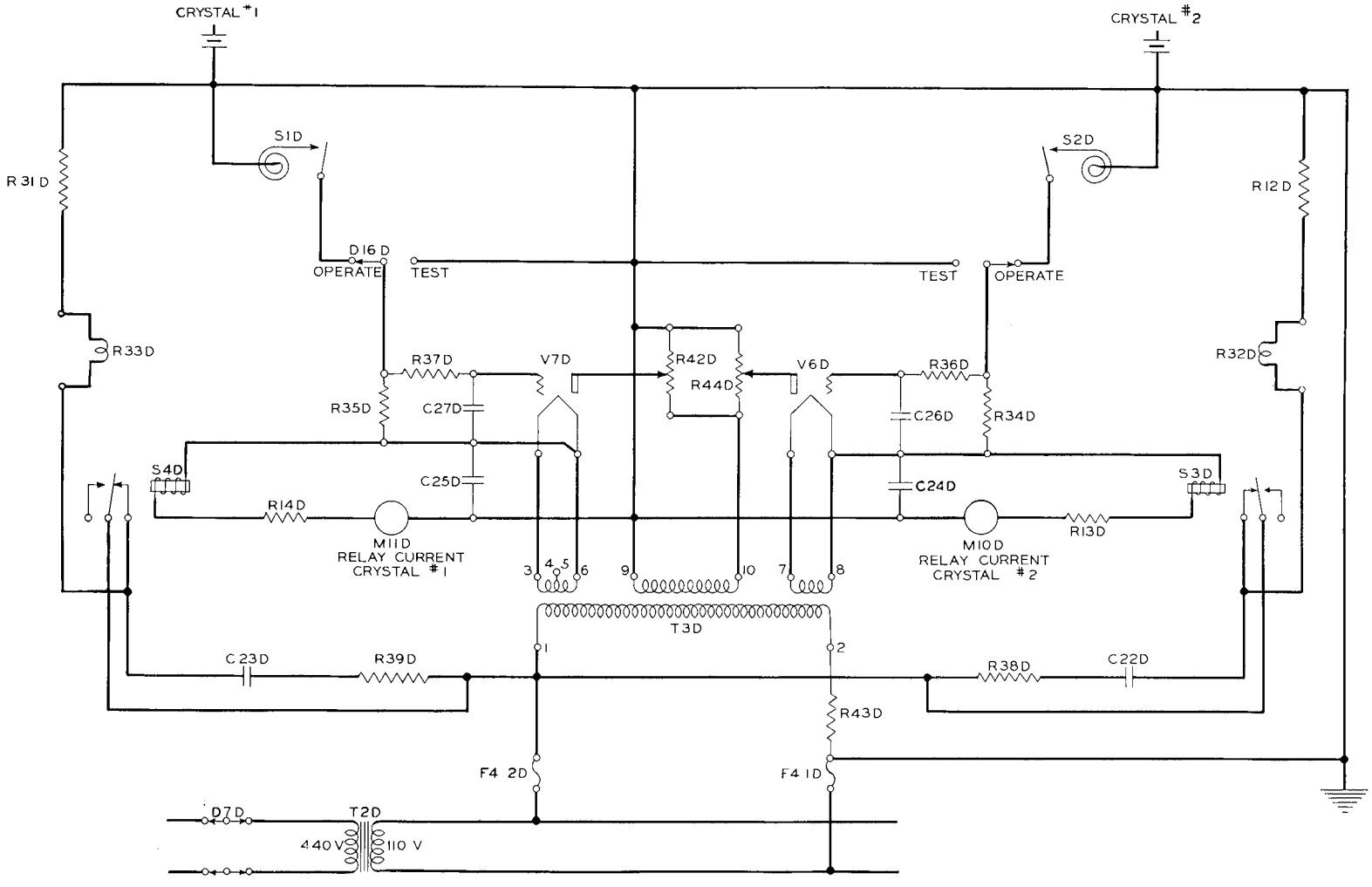


Component Parts of No. D-88357 Antenna Switching System

D1N is inside of the Antenna Switch Control Box and as the cover of the box is provided with a lock D1N may be locked effectively in the "OFF" or "ON" position. When D1N is in the "ON" position either one or the other of the lights R1N and R4N will be lighted depending on the position of D6N. If D6N is connected to the ground terminal a red light will show from R4N and no light from R1N as R1N and R2N will be shorted by D4.2N and conversely if D6N is connected to the "TRANSMIT" terminal a green light will show from R1N and no light from R4N as R3N and R4N will be shorted by D5.2N. If the blade of D6N does not make contact with either the "GROUND" or "TRANSMIT" terminal both the red and green light will show but with low intensity for under this condition both D4.2N and D5.2N are open.

The motor circuit is controlled also through the push button switches D2.1N and D2.2N in the antenna switch control box and through D3.1N and D3.2N located in the antenna coupling house. In addition the motor circuit is automatically disconnected by D4.1N or D5.1N when the blade of D6N makes contact with either the "GROUND" or "TRANSMIT" terminals.

In order to change D6N from either the "TRANSMIT" or the "GROUND" posi-

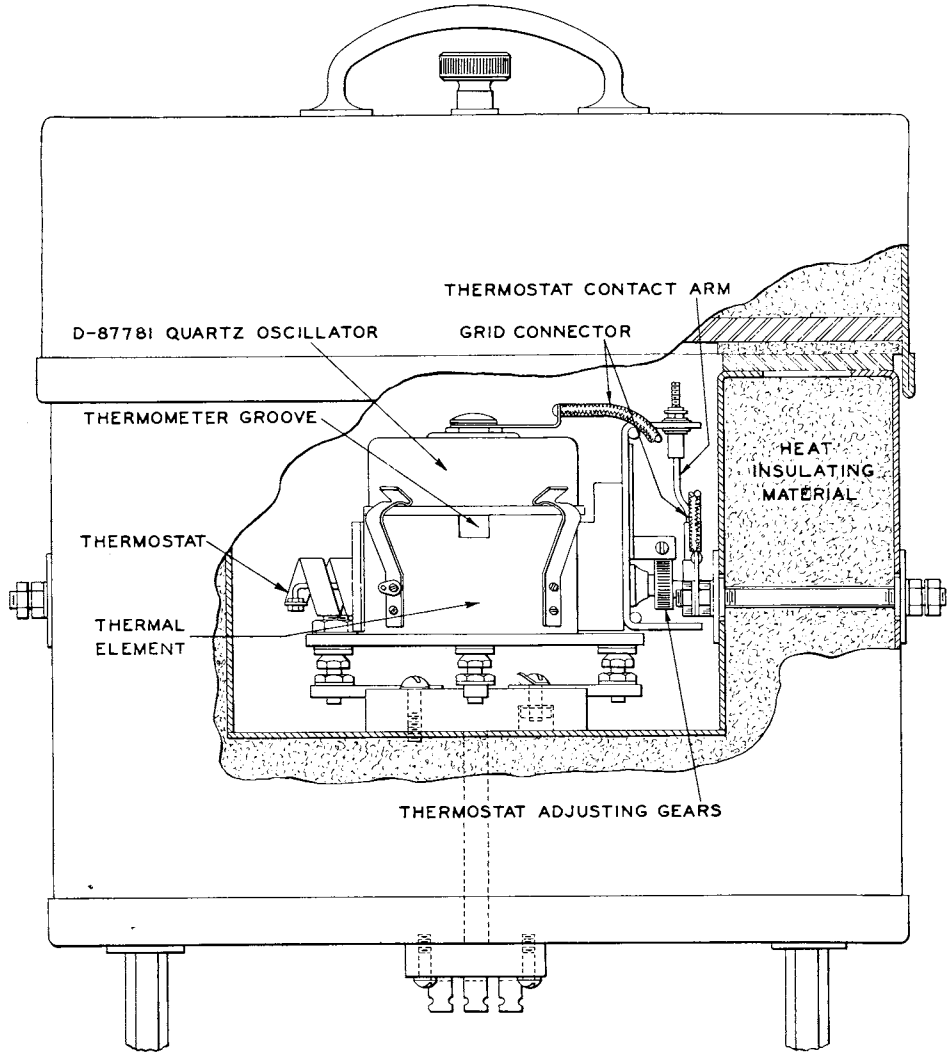


Temperature Control Circuit

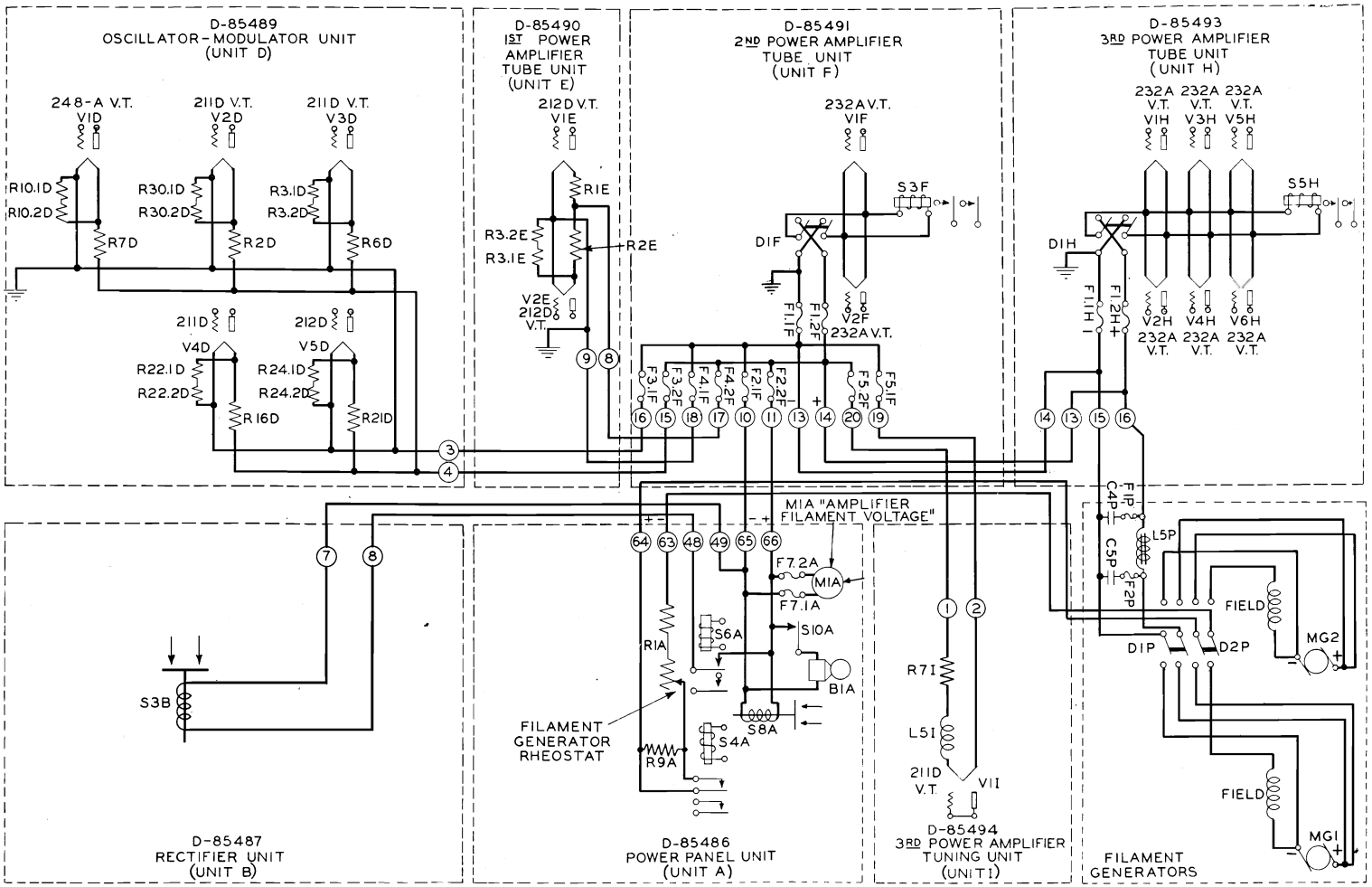
tion to the opposite position the control switch button must be pressed continuously during the time interval required for the blade to make the transit. However, no harm is done if the button is released as the motor simply stops and it is only necessary to push the button again till either the red or green light shows with full intensity. R2N and R3N are current limiting resistances in series with the lamps R1N and R4N.

Quartz Oscillator Temperature Control Circuit.

The DC power supply (see pages 28 and 156) is obtained by using vacuum tubes V6D and V7D in a self rectifying circuit, the plate circuit voltage being controlled by means of a potentiometer. The inductance of the winding of S4D together with C25D form a filter which smooths out most of the ripple in the plate circuit.

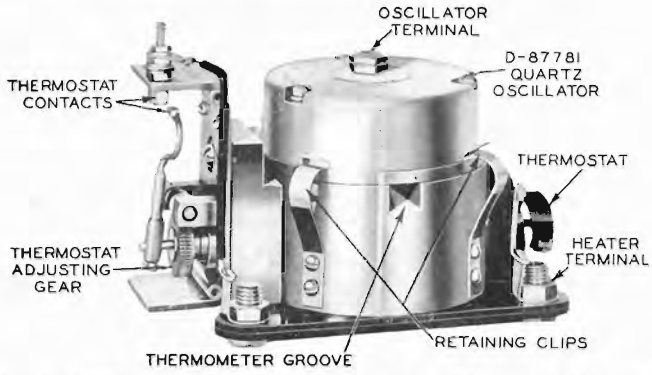


No. D-86767 Crystal Heater Unit



Filament Circuit

The grid of V7D is connected to the filament through the resistances R37D and R35D when the contact of the thermostat S1D is open. When the grid is connected to the filament through these resistances, it has substantially no negative biasing potential hence the plate current is relatively large, sufficient to cause S4D to operate. When the contacts of the thermostat S1D are closed the grid of V7D is biased by a negative potential equal to the voltage drop along the resistance R14D and the relay S4D which results from the plate current passing through these elements. With the grid biased by this voltage the current in the plate circuit is reduced to a small value, sufficiently small to cause the armature of S4D to release. The opening and closing of the contacts of S1D is controlled by the temperature of the quartz oscillator.

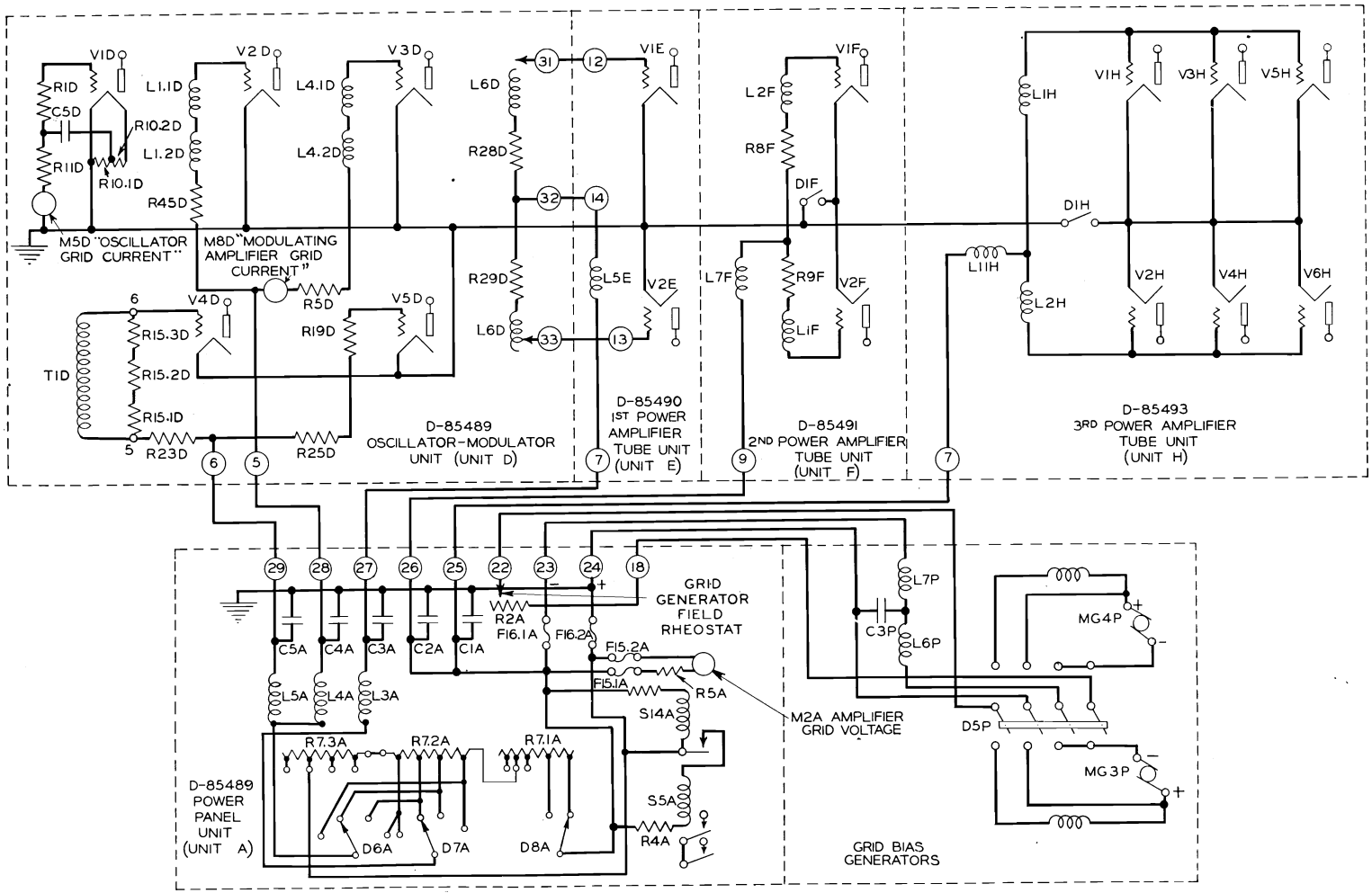


No. D-87781 Quartz Oscillator and Thermal Element

When the temperature is less than the temperature at which the contacts of S1D close, the current through the winding is sufficient to operate S4D. This operation will close the power circuit. The heat thus produced raises the temperature of the quartz oscillator and the heater box.

When sufficient heat has been added the temperature of the thermostat will rise to a value which will cause its contacts to close. When the thermostat contacts close the plate current in V7D is reduced to a value which causes S4D to operate. This will stop the addition of heat to the heater box and the temperature of the quartz oscillator and the thermostat will decrease gradually as the heat from the interior of the box is conducted through the insulation to its exterior where it is lost to the surrounding air. As the temperature of the thermostat decreases, its contact will move apart and open the circuit which biases the grid of V7D.

The current in the heater circuit passes through the lamp R33D. This light is used as a signal that the heater circuit is closed; as the heat cycle is repeated at intervals of about two minutes the light from R33D will flash off and on. The flashing of the light is an indication that the vacuum tube relay is operating correctly but if the light shows continuously or does not appear for a long interval of time, it is possible that the vacuum tube relay circuit is not operating correctly. Sparking at the contacts of S4D is prevented by C23D and R39D connected across the contacts.



Grid Bias Circuit

Each quartz oscillator is calibrated and must be operated at a particular temperature in order to obtain the proper frequency. The temperature of the quartz oscillator is varied by adjusting the thermostat S1D. The detailed instructions on the method of adjusting the contacts of the thermostat to obtain the desired temperature are given in section Adjustment of Apparatus and Circuits.

Filament Circuit

The filaments of all the amplifier vacuum tubes in the transmitter are heated by current from a 20-volt DC generator, in some cases through a current limiting resistance. The complete filament circuit is shown on pages 30 and 157.

Filament current is supplied from either of two filament generators which are designated MG1 and MG2. Either of these generators may be connected to the filament circuit by means of switches D1P and D2P. Electrolytic condensers C4P and C5P together with retardation coil L5P form a filter to smooth out the ripple of the generator.

The filament generator field circuit includes R1A, and R9A shunted by a contact circuit of S4A. R9A must be shorted by the contacts of S4A before the filament voltage will build up to 20 volts. The value of the residual voltage when R9A is not shorted is about 6 volts.

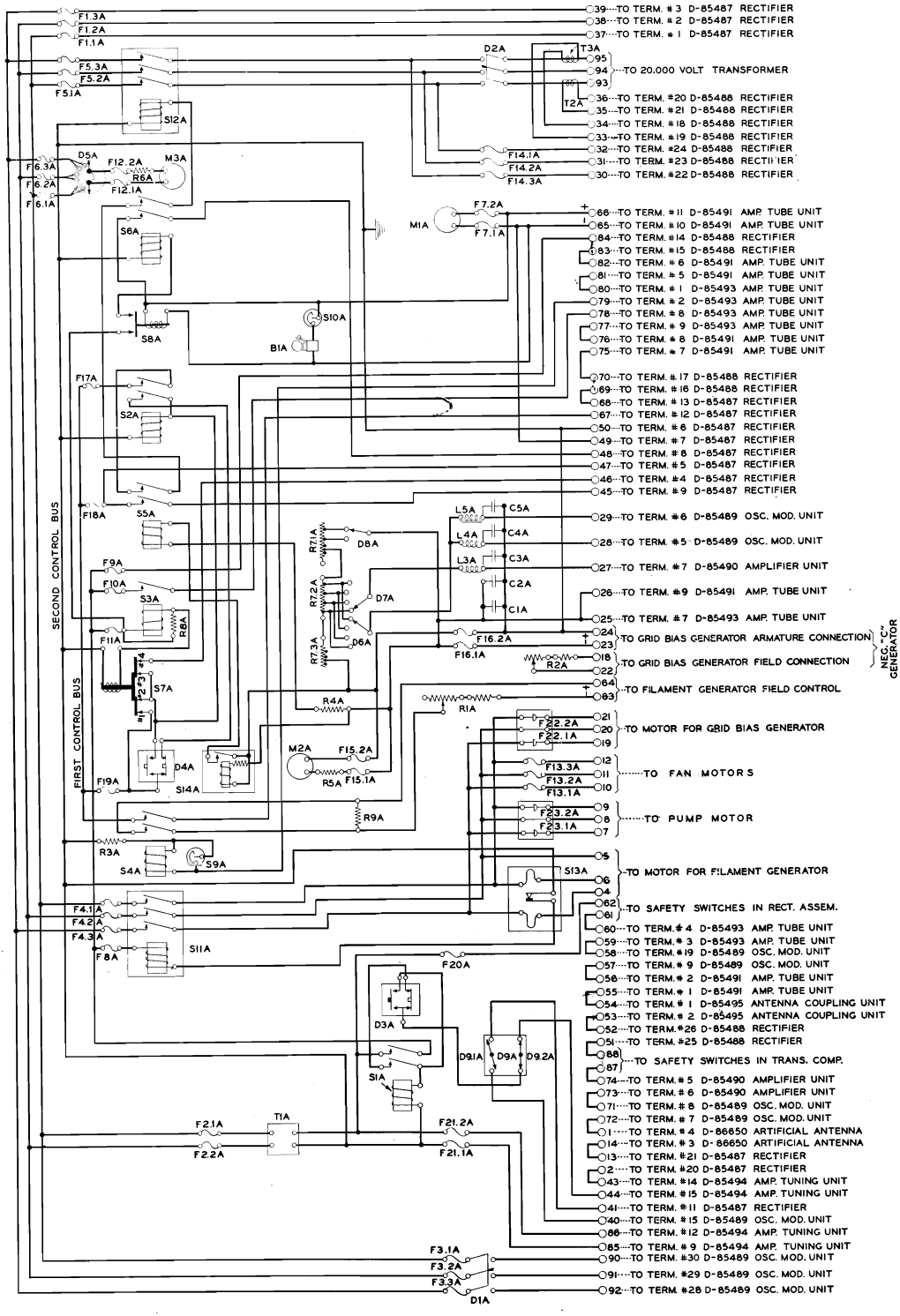
The vacuum tubes of the second and third amplifiers are connected to the filament circuit through the polarity changing switches D1F and D1H, respectively, these switches being provided for the purpose of reversing at regular time intervals, the polarity of the voltage applied to the filaments. This is done to balance the unequal heating at the two ends of the filament due to the plate current, thus prolonging the filament life.

Relays S3F and S5H are provided to protect the vacuum tubes from being damaged by the application of the plate voltage in case the filaments are not heated.

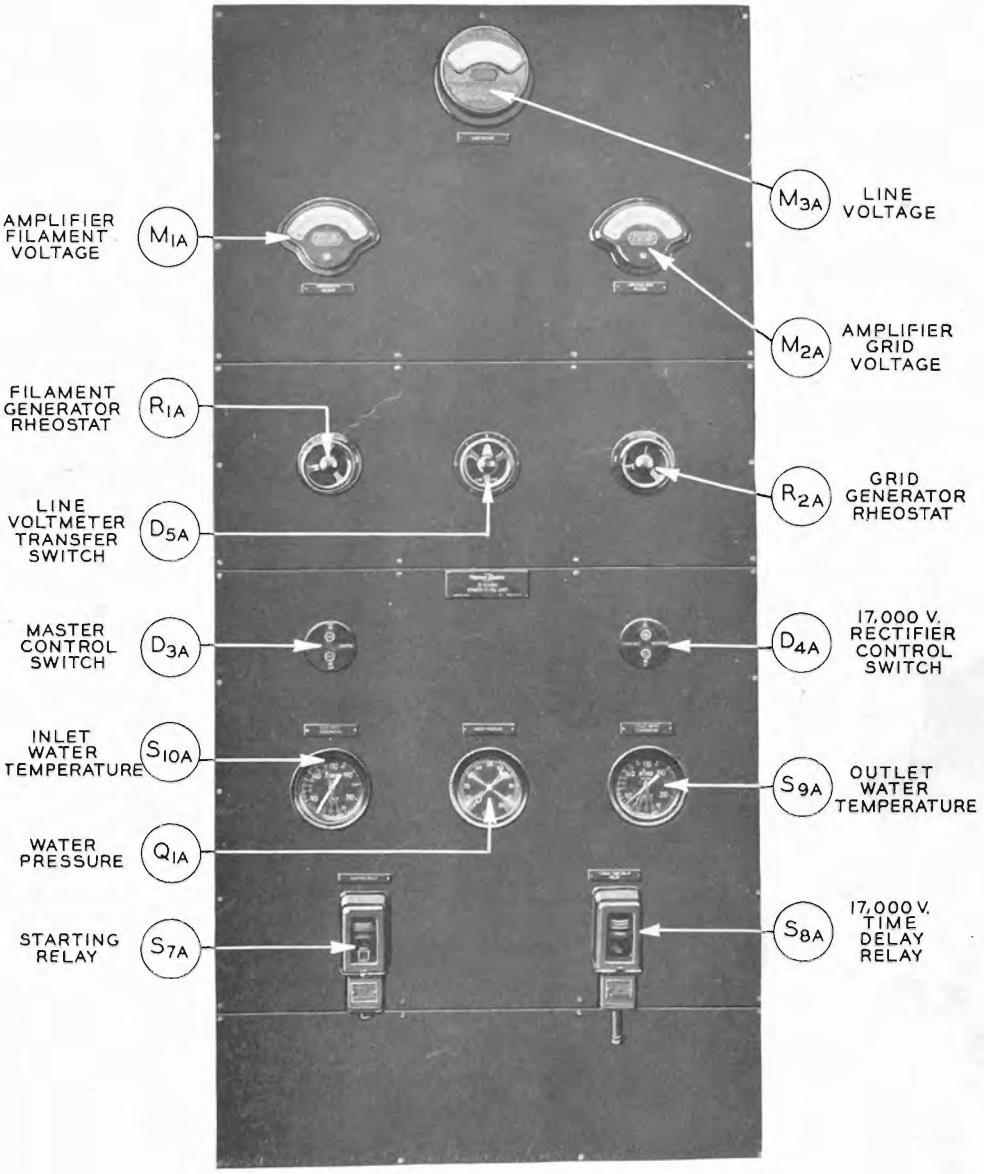
Grid Bias Circuit

The complete grid bias circuit is shown on pages 32 and 158. All of the amplifier tubes are supplied with a grid bias voltage obtained from a DC generator. Two grid bias generator sets designated as MG3 and MG4 are provided. Either one of these generators may be connected to the transmitter circuits by means of the switch D5P. The circuit from the grid bias generator is connected to the No. D-85486 Power Panel Unit and from there the circuit branches to each of the units in the transmitter containing amplifier tubes. The generator ripple is smoothed out by means of a filter consisting of condenser C3P and retardation coils L6P and L7P. The voltage of the grid generator is adjusted to 300 volts by means of rheostat R2A which is in series with the field of the generator.

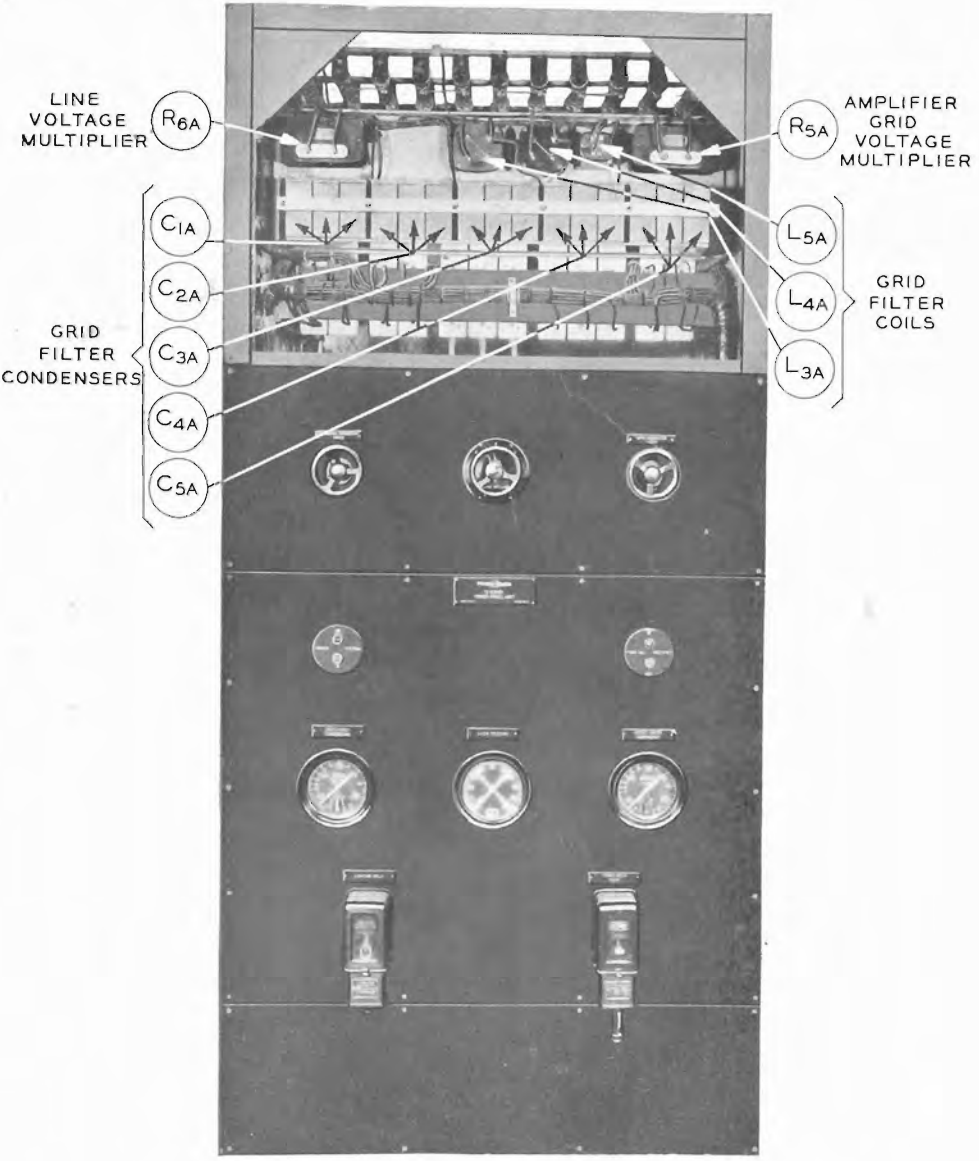
Resistance R7A has a double purpose in the circuit; first, that of providing a definite load for the grid generator thus maintaining good voltage regulation and second, the voltage drop along a part of these resistances is used to provide particular values of grid voltage for the tubes in the Oscillator-Modulator Unit



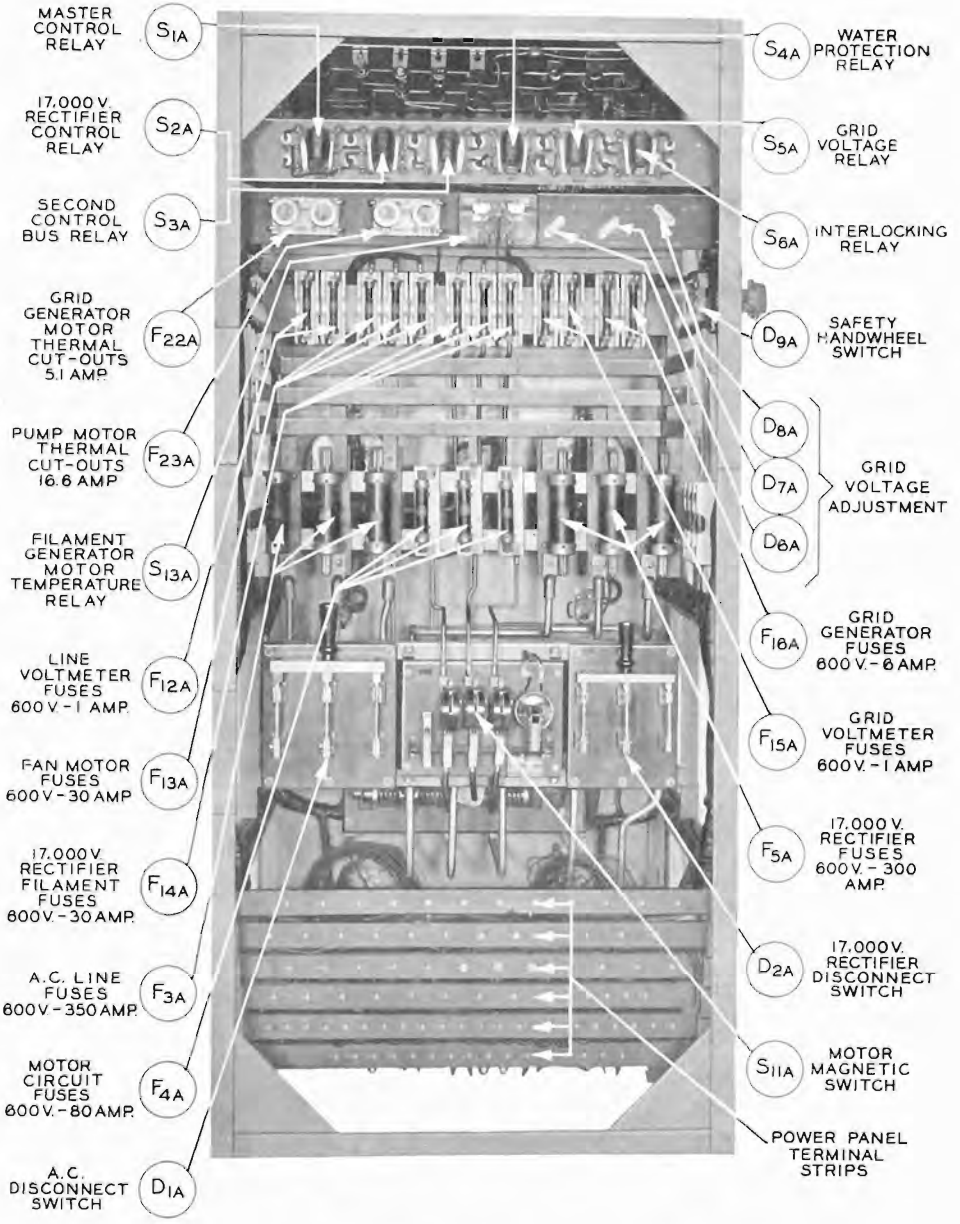
Schematic of No. D-85486 Power Panel Unit
(See also large diagram in envelope)



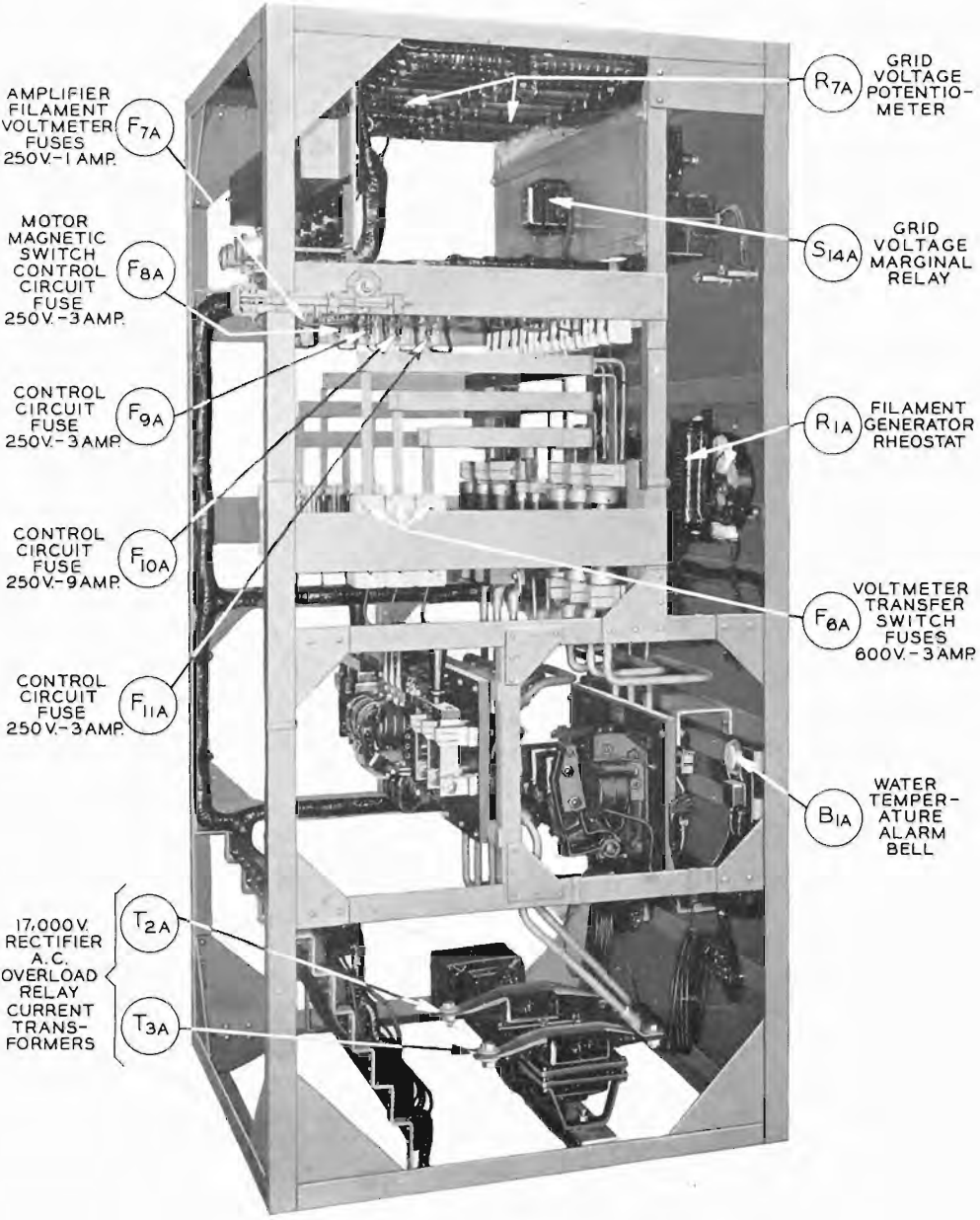
No. D-85486 Power Panel Unit—Front View



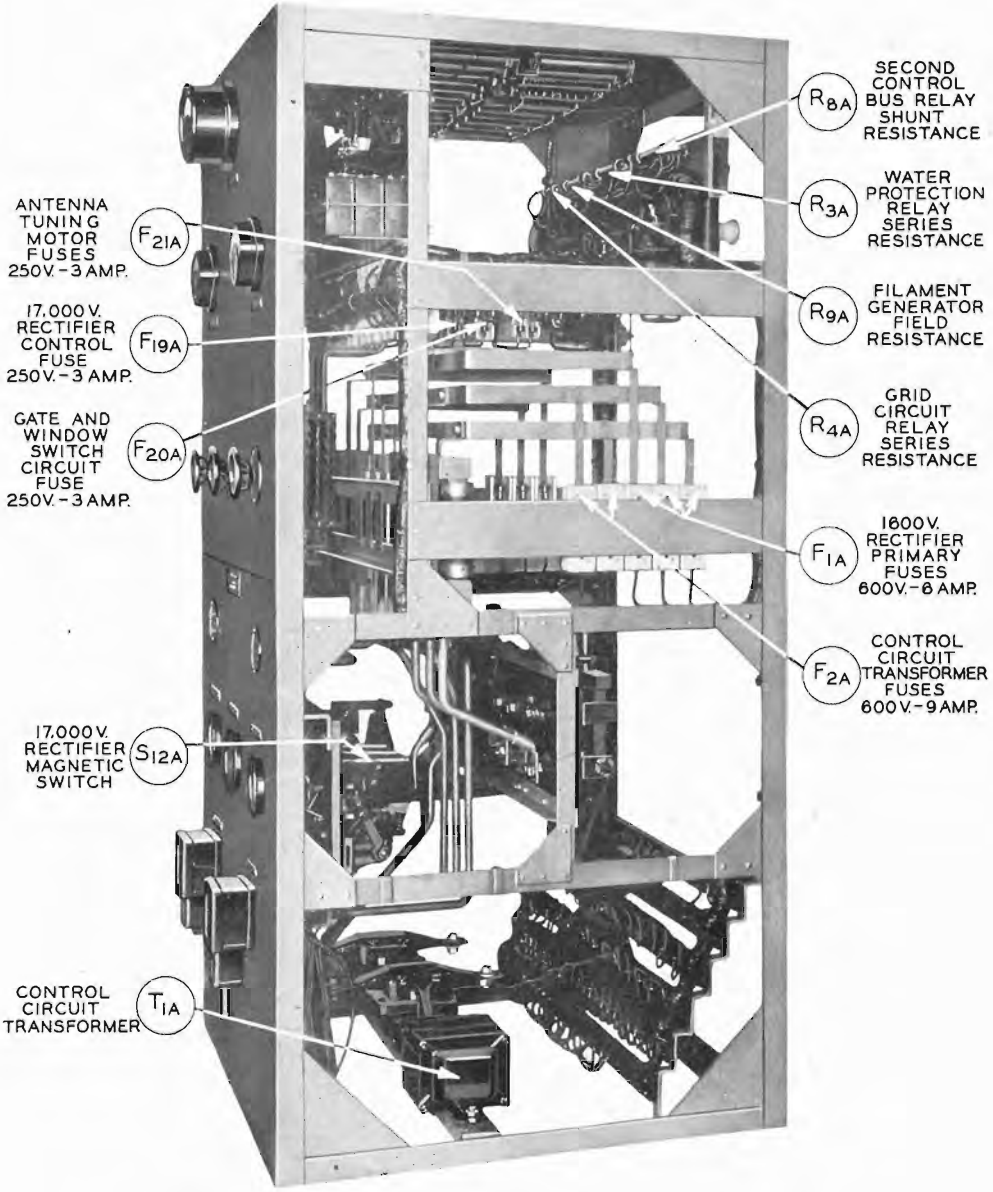
No. D-85486 Power Panel Unit—Front View —Meter Panel Removed



No. D-85486 Power Panel Unit—Rear View



No. D-85486 Power Panel Unit—Left Side View



No. D-85486 Power Panel Unit—Right Side View

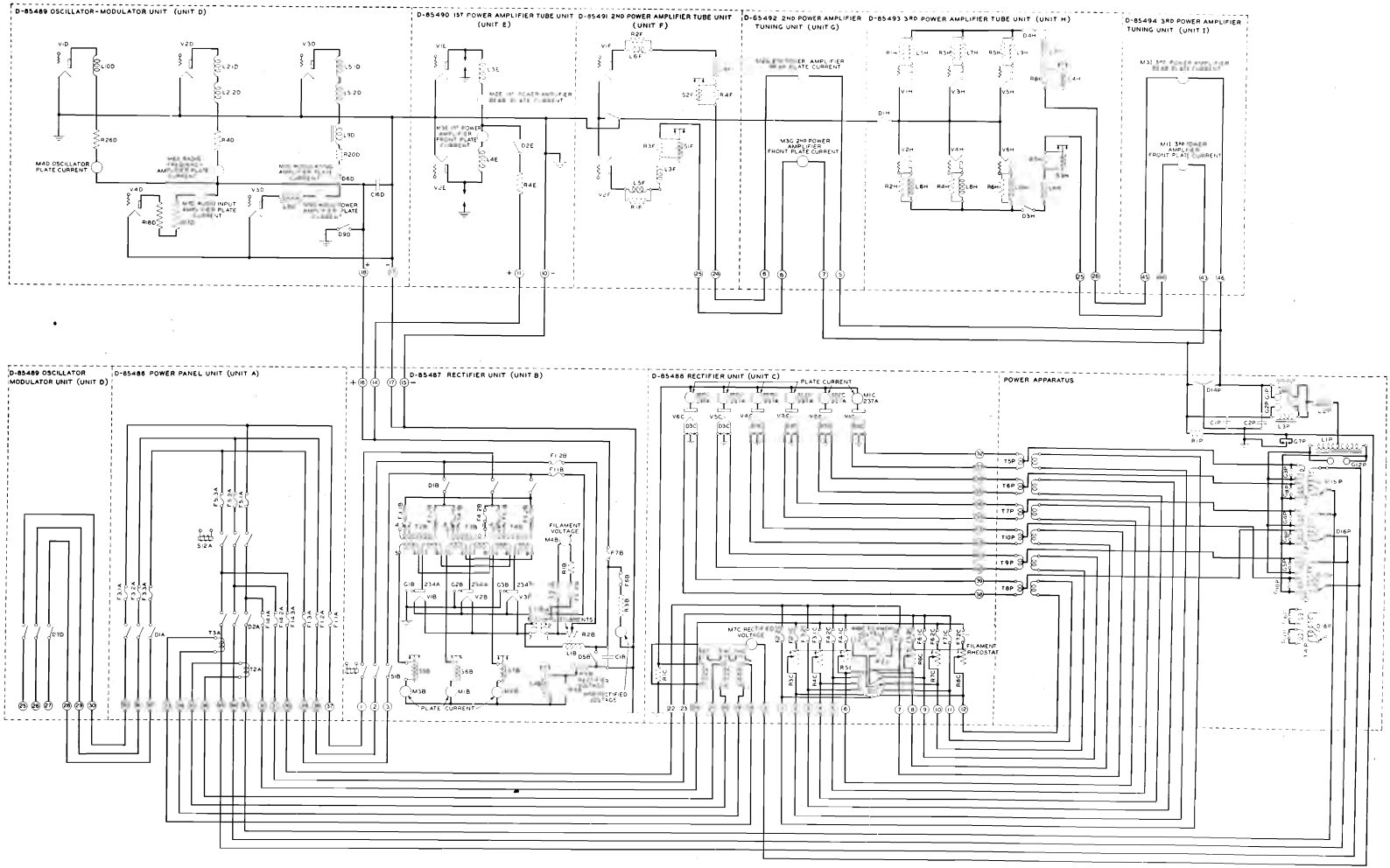


Plate Voltage Circuits (*See also large diagram in envelope*)

and in the First Power Amplifier Unit. Links D6A and D7A are set on positions whose numbers agree with the class numbers of the No. 212D Tubes used in these units.

The water-cooled tubes are biased by a grid voltage of 300 volts and D8A is set on the point marked with this voltage.

The coils L3A, L4A and L5A in series with the circuit to the grids of the low power tubes, and the condensers C1A, C2A, C3A, C4A and C5A form filters which smooth out the ripples in the grid bias voltage.

Relay S5A is connected across the grid voltage circuit through the contact circuit of S14A, and the current limiting resistance which is mounted as part of the relay. The contact circuits of S5A are in series with a circuit which controls the application of the plate voltage to all vacuum tubes, as explained under Control Circuits.

Plate Voltage Circuits

The complete plate voltage circuit is shown on pages 40 and 163. Plate voltage for all the vacuum tubes is obtained from two rectifiers. One rectifier provides a 1,600-volt supply for the radiation-cooled tubes and the other rectifier provides a 17,000-volt supply for the water-cooled tubes.

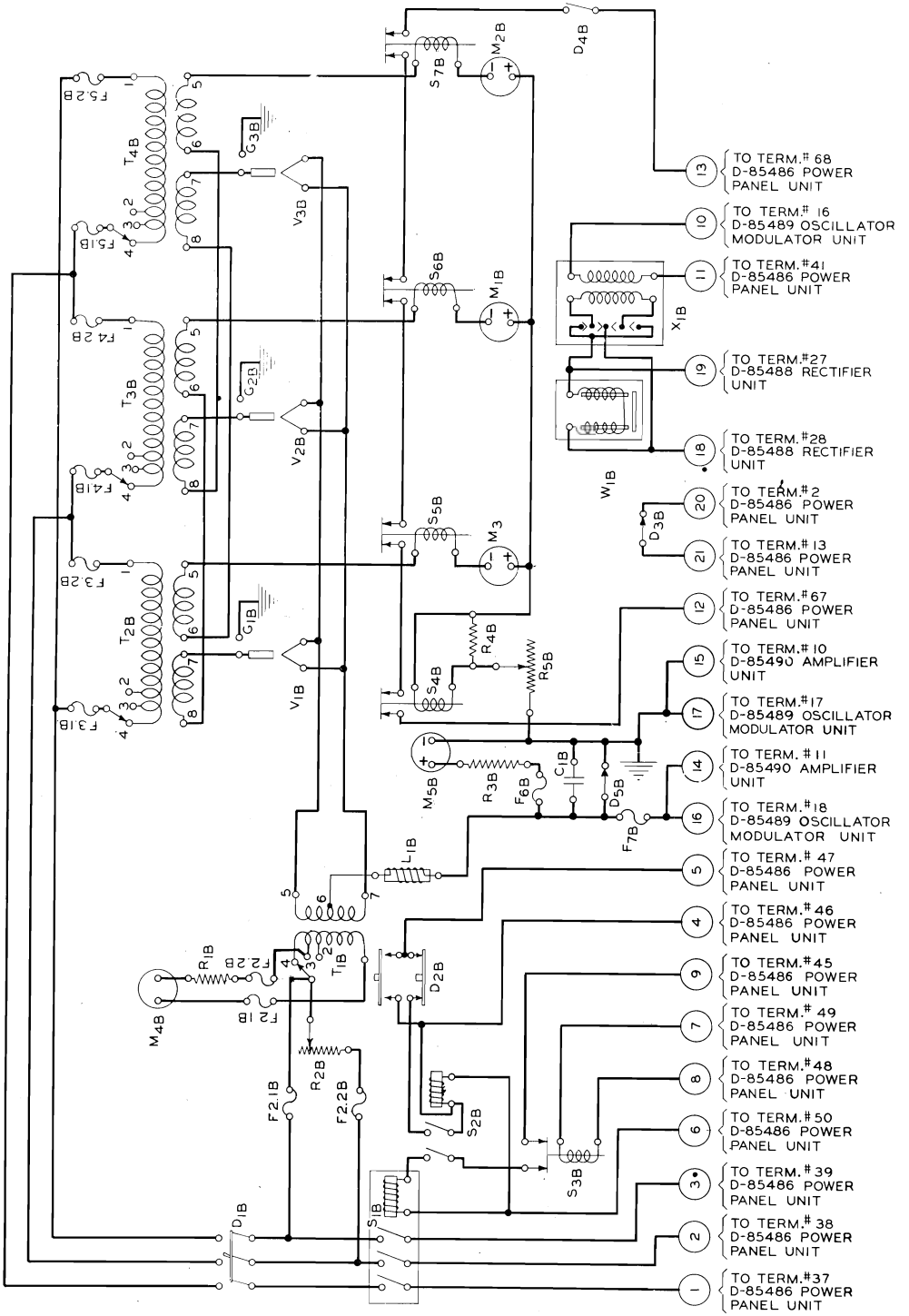
Both rectifier units obtain power from the 440-volt three-phase, 60-cycle supply. Control of both the 1,600-volt and 17,000-volt plate current is obtained by opening the connection from this power supply to the primary circuits of the transformers in the rectifier units.

1,600-*Volt Plate Supply.*

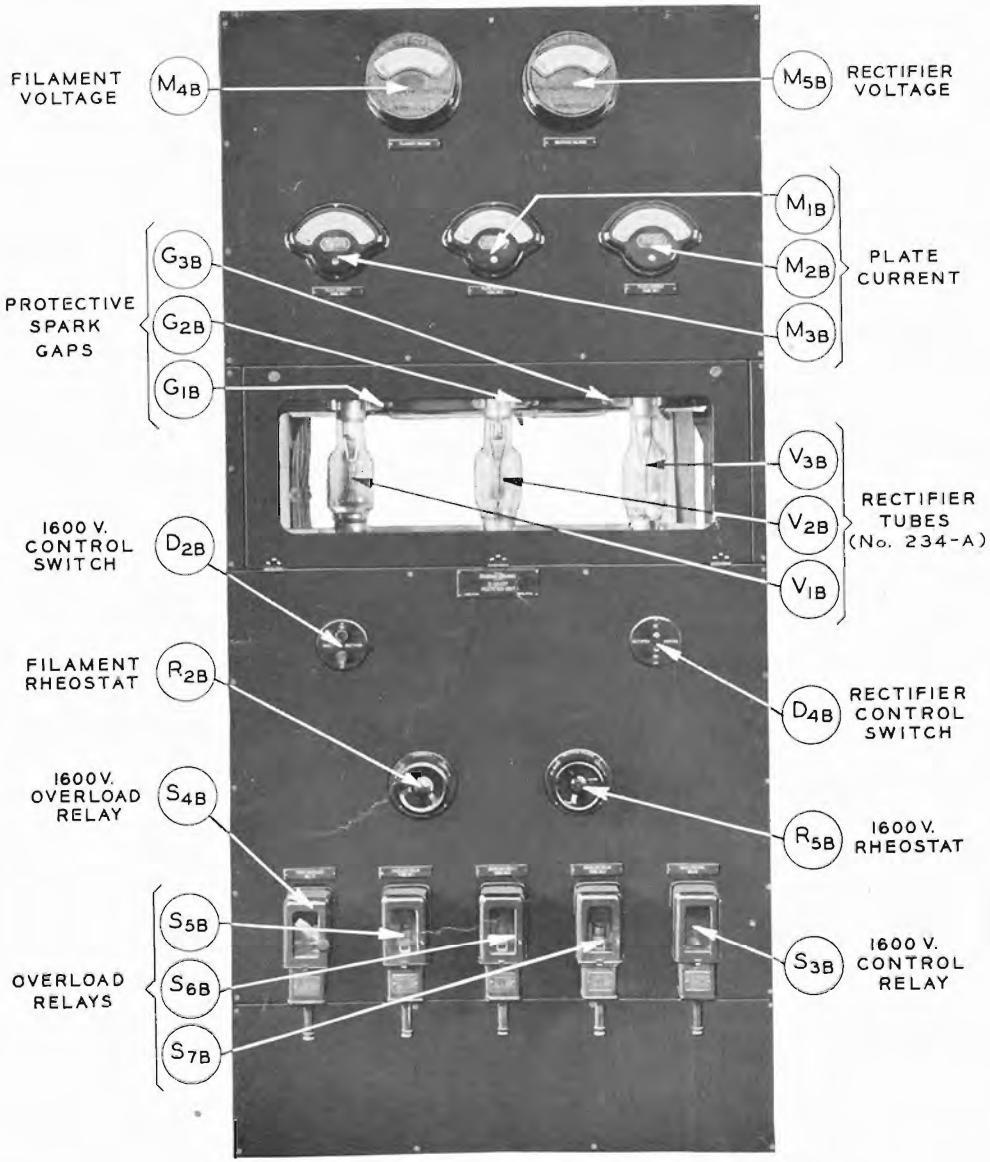
The 1,600-volt plate supply is obtained from a three-phase rectifier in which the filaments of the rectifier tube are 1,600 volts DC above ground when the rectifier is in operation. The secondaries of the high voltage supply transformers T2B, T3B and T4B are connected so as to form a distributed "Y" circuit. The filament voltage is adjusted by means of R2B so that "FILAMENT VOLTAGE" meter M4B reads 400 volts. Retard coil L1B and condenser C1B form the filter for the rectifier output.

This apparatus is known as the No. D-85487 Rectifier Unit, the schematic diagram of which is shown on pages 42 and 164 with the front, rear and both side views shown in the illustrations on pages 43 to 46 inclusive. The entrance of the Power Unit Assembly is shown on page 47.

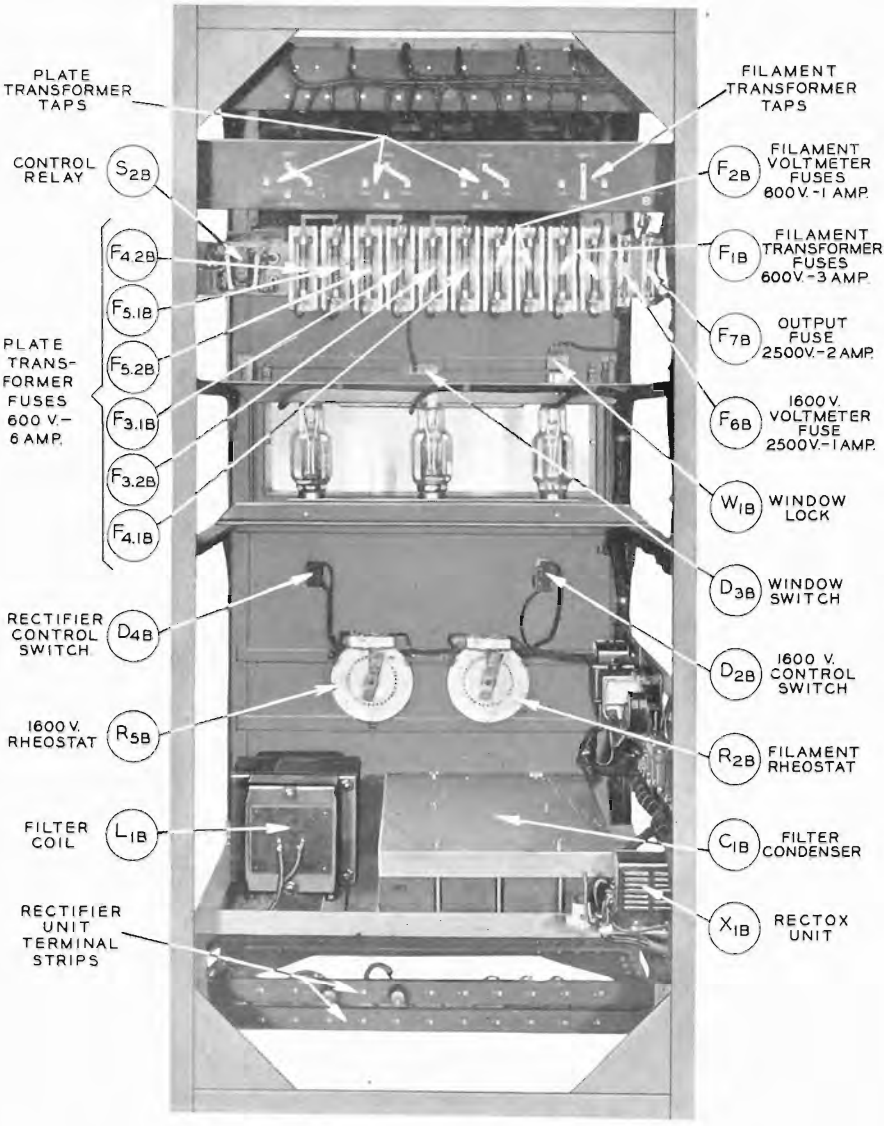
When the handwheel at the entrance to the Power Unit Assembly is operated to open the gate to the enclosure, switch D5B closes, grounding and short-circuiting the 1,600-volt circuit. D9D performs a similar function when the handwheel at the entrance to the transmitter assembly is operated. D1B provides a means for heating the filaments of the rectifier tubes without applying voltage to the plates.



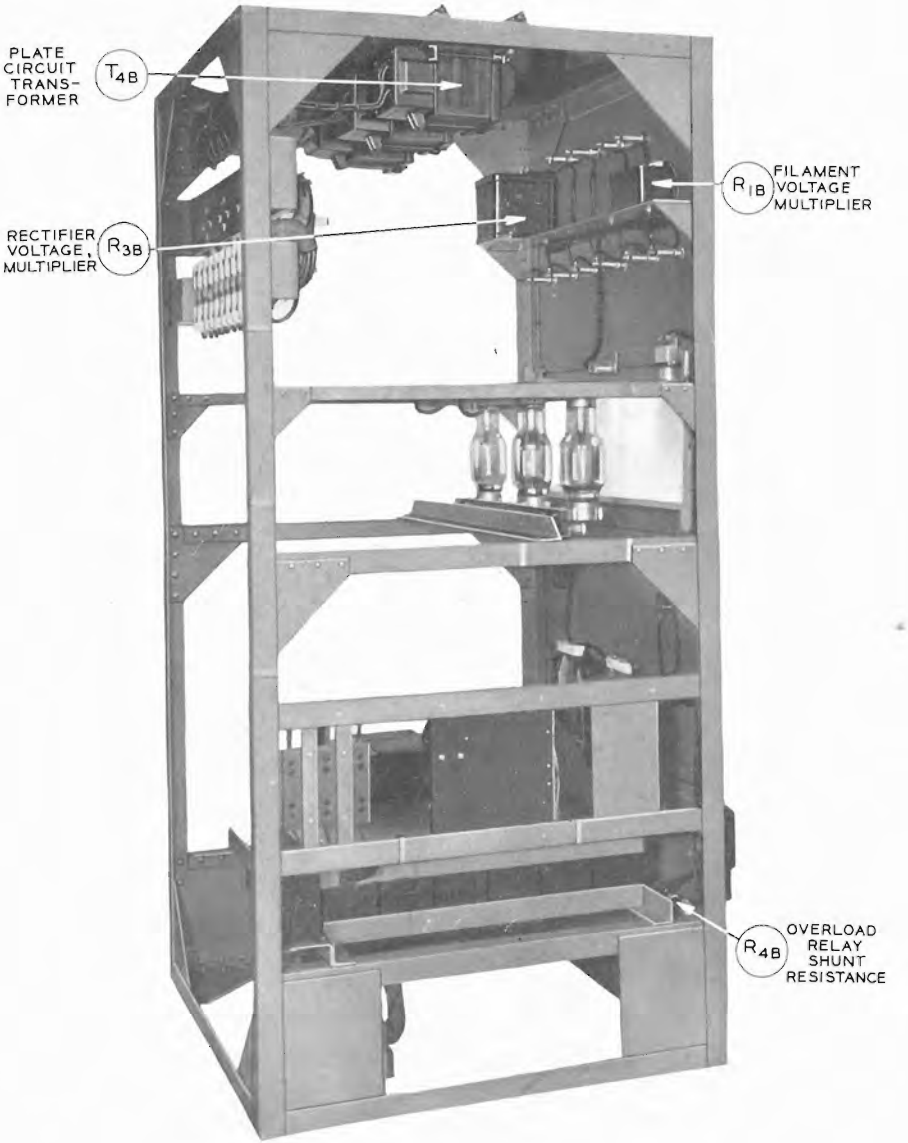
Schematic of No. D-85487 Rectifier Unit



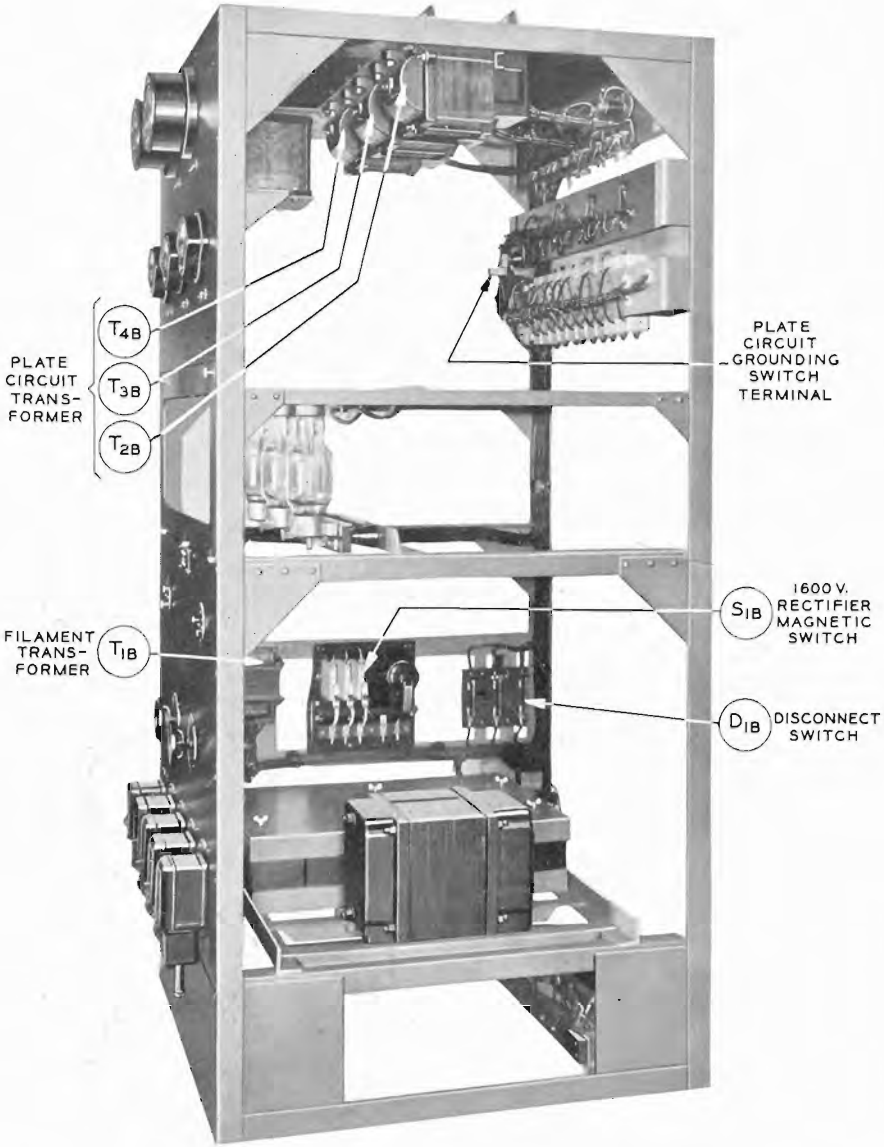
No. D-85487 Rectifier Unit—Front View



No. D-85487 Rectifier Unit—Rear View



No. D-85487 Rectifier Unit—Left Side View

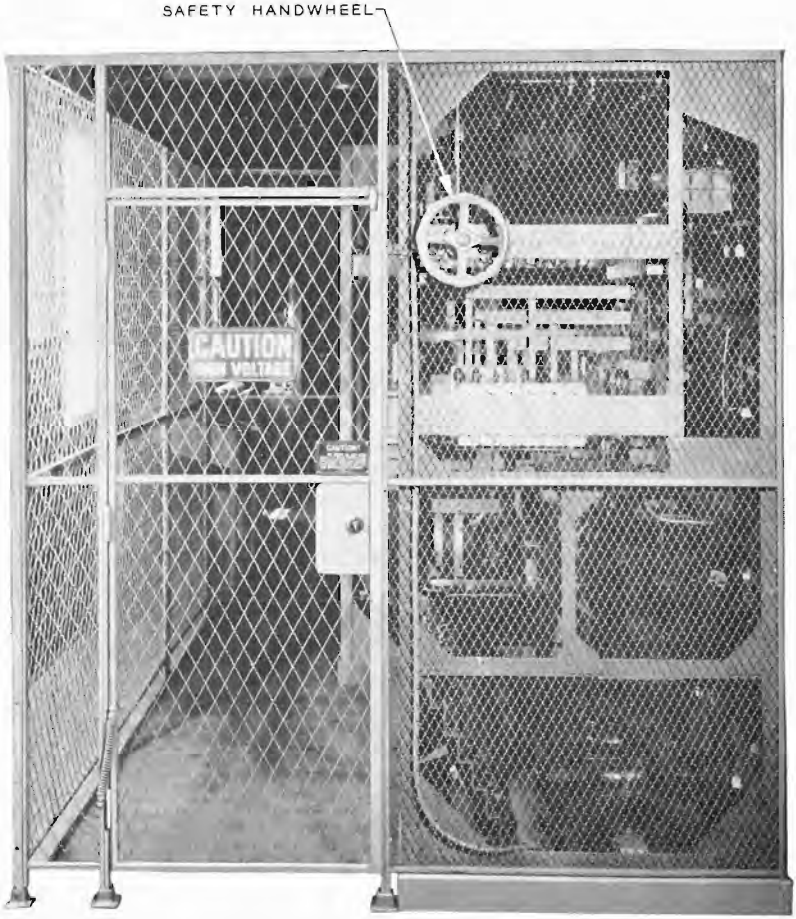


No. D-85487 Rectifier Unit—Right Side View

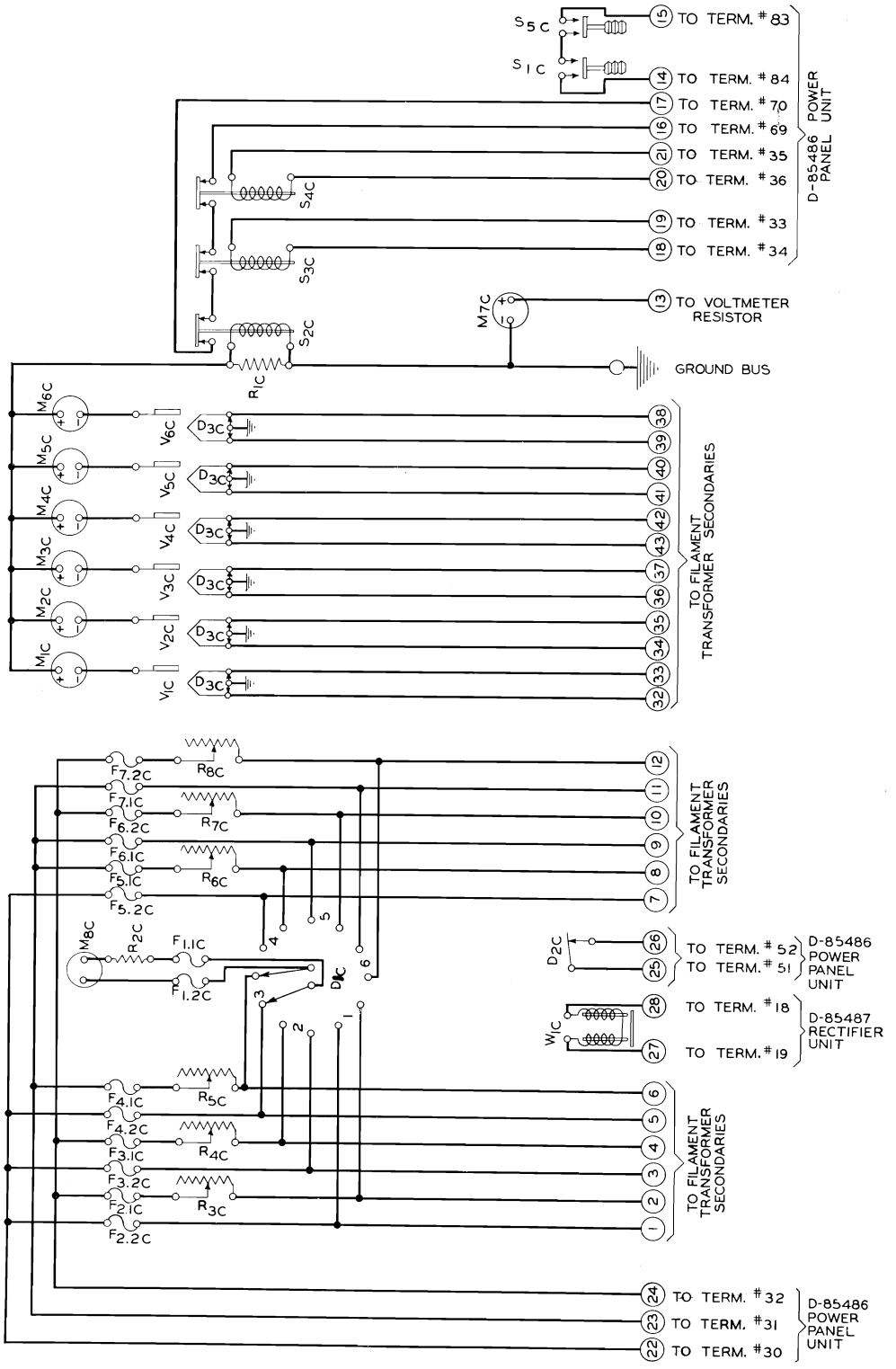
17,000-*Volt Plate Supply.*

The 17,000-volt rectifier employs a double three-phase circuit in which the secondary windings of the plate transformers T1P, T2P and T3P are connected in a double "Y" arrangement with the "Y's" connected 180 degrees out of phase with respect to each other. The common terminals of the "Y's" are connected together through an interphase reactance coil L1P. The filaments of the six rectifier tubes are each heated from one of six separate transformers, T5P to T10P, the center tap of the secondary winding of each transformer being connected to an outer terminal of a secondary winding of a plate transformer. Two filament transformers are connected to each phase of the power supply.

The rectifier tubes, the filament voltage control rheostats, the plate current meters and the overload relays are located in the No. D-85488 Rectifier Unit, while the filament transformers and the filter for the 17,000-volt supply are located in the transformer and filter room.

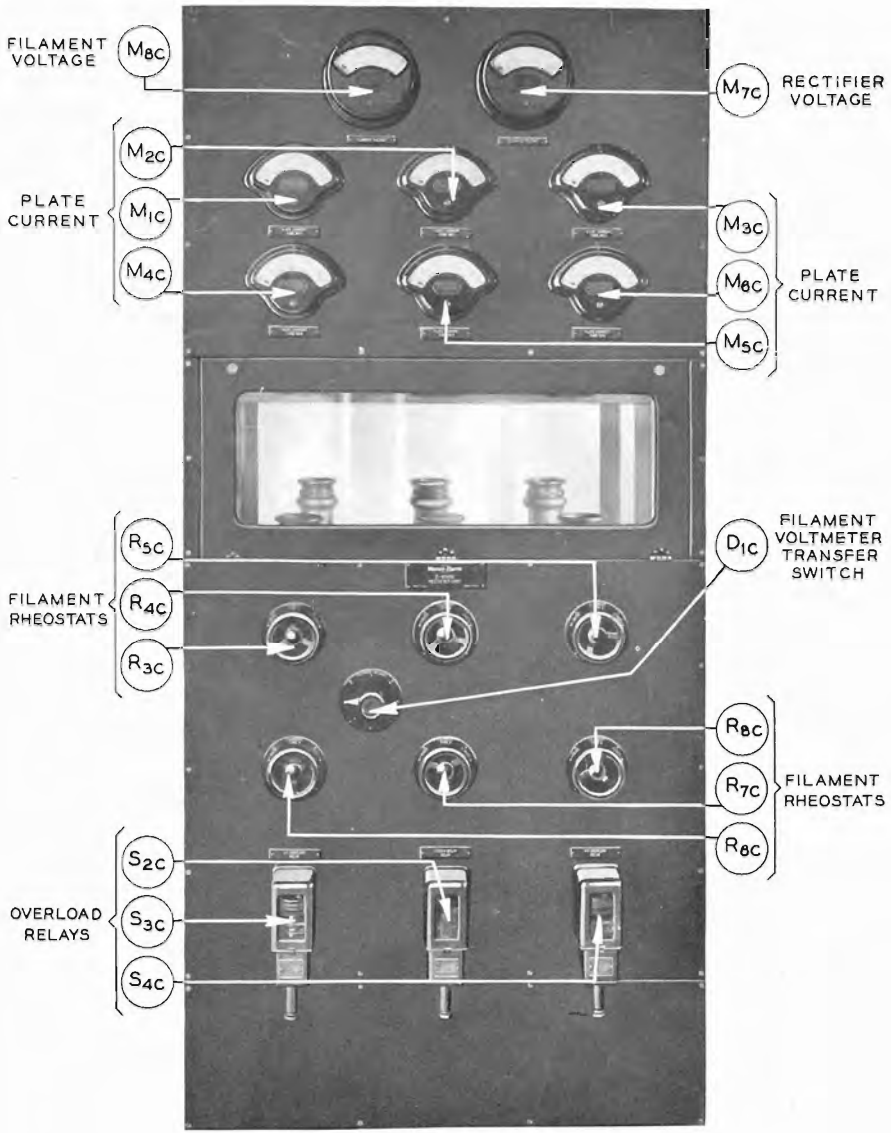


Entrance to Power Unit Assembly



Schematic of No. D-85488 Rectifier Unit

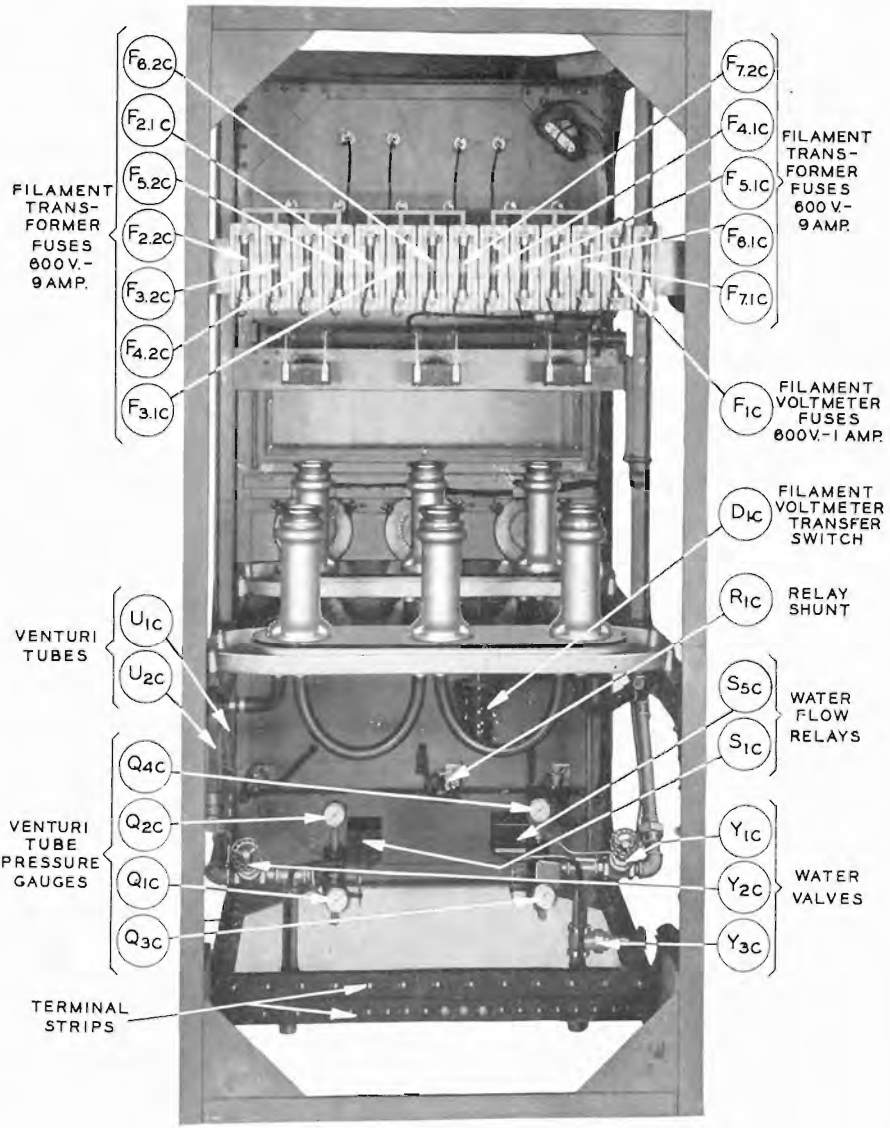
The voltage of the filament circuit is measured by the "FILAMENT VOLTAGE" meter M8C which can be connected to any one of the primary circuits of the filament transformers by means of the multiple contact switch D1C. The filament voltage of each tube is controlled separately by means of a rheostat placed in series with the primary windings of the filament transformers (R3C to R8C). The power supply leads to the primary windings of the plate circuit transformers are connected to switch D2A in the No. D-85486 Power Panel Unit which acts as a safety disconnect switch and which allows the filaments of the rectifier tubes in the 17,000-Volt Rectifier Unit to be lighted without applying the high voltage to them.



No. D-85488 Rectifier Unit—Front View

The contacts of the relays S2C, S3C and S4C are connected in series and, as explained under Control Circuits, are in a circuit which controls the operation of the magnetic switch S12A.

The 17,000-volt plate supply circuit is divided into two branches referred to as the front and rear 17,000-volt buses. Each branch is used as a plate voltage supply lead for the tubes grouped together on the opposite sides of the second and third power amplifier circuits. Each of these branch circuits is provided with a filter. The filter connected to the front bus consists of the coil L3P and the condenser C1P while the filter connected to the rear bus consists of the coil L4P and the condenser C2P. This voltage is measured by M7C.



No. D-85488 Rectifier Unit—Rear View

are supported on a panel of insulating material held by the metal trays. The plate voltage supply circuit is completed from the metal tray bus to the individual jackets through the anti-sing inductance coil and resistance units.

When the handwheel at the entrance to the enclosure of the Power Unit Assembly is operated so as to allow the gate to the enclosure to be opened, the switch D3C is closed and grounds the filament circuit of the rectifier tubes. The switch D14P in the 17,000-volt filter circuit is a protective switch operated by a similar handwheel at the entrance to the transformer and filter room. The protector G7P is provided for the purpose of limiting the voltage that may occur in the circuit of the meter M7C in case this circuit should be open between the meter and the ground connection.

Radio Frequency Circuits

The radio and audio frequency circuits are shown on pages 52 and 168. All of the circuits are shielded. The shielding is indicated in the circuit diagrams by the thin dashed line enclosures around the different groups of apparatus.

No. D-85489 Oscillator Modulator Uni

PAGE 51, 52 GONE

The Oscillator Modulator is provi oscillators. Either one may be selected to control the freq gnal by operating the "CRYSTAL SELECTOR" switch D10D. The schematic of the Oscillator Modulator Unit is on pages 54 and 170 and the unit is illustrated on pages 55 to 61 inclusive.

V1D together with one of the quartz oscillators, R1D and R11D and the coil L10D form the oscillator circuit. The magnitude of the radio frequency voltage applied to the quartz oscillator through the tube capacity may be adjusted by means of D3D and the associated plate circuit taps of D10D. Reducing the number of turns included in the plate circuit will reduce the magnitude of the voltage.

The radio frequency voltage applied to V1D is sufficient to cause the grid to go positive with respect to the filament; this causes current to flow in the grid circuit which passes through R1D, R11D and the "OSCILLATOR GRID CURRENT" meter M5D.

Condenser C5D, connected between the junction of R1D and R11D and the mid point of R10.1D and R10.2D, forms in combination with R11D a simple filter circuit which acts to reduce the noise from alternating components of the voltage drop along the filament of V1D. C19D is a radio frequency by-pass condenser for the plate circuit.

The input voltage to the grid of V2D may be varied or controlled by either adjusting the condenser C18D for small variations or by means of D4D and the taps on L10D for larger variations. C20D is a plate voltage stopping condenser.

The tuned output circuit of the radio frequency amplifier V2D is connected to the plate of V2D through the plate voltage stopping condenser C2D. The

are supported on a panel of insulating material held by the metal trays. The plate voltage supply circuit is completed from the metal tray bus to the individual jackets through the anti-sing inductance coil and resistance units.

When the handwheel at the entrance to the enclosure of the Power Unit Assembly is operated so as to allow the gate to the enclosure to be opened, the switch D3C is closed and grounds the filament circuit of the rectifier tubes. The switch D14P in the 17,000-volt filter circuit is a protective switch operated by a similar handwheel at the entrance to the transformer and filter room. The protector G7P is provided for the purpose of limiting the voltage that may occur in the circuit of the meter M7C in case this circuit should be open between the meter and the ground connection.

Radio Frequency Circuits

The radio and audio frequency circuits are shown on pages 52 and 168. All of the circuits are shielded. The shielding is indicated in the circuit diagrams by the thin dashed line enclosures around the different groups of apparatus.

No. D-85489 Oscillator Modulator Unit.

The Oscillator Modulator is provided with two quartz oscillators. Either one may be selected to control the frequency of the carrier signal by operating the "CRYSTAL SELECTOR" switch D10D. The schematic of the Oscillator Modulator Unit is on pages 54 and 170 and the unit is illustrated on pages 55 to 61 inclusive.

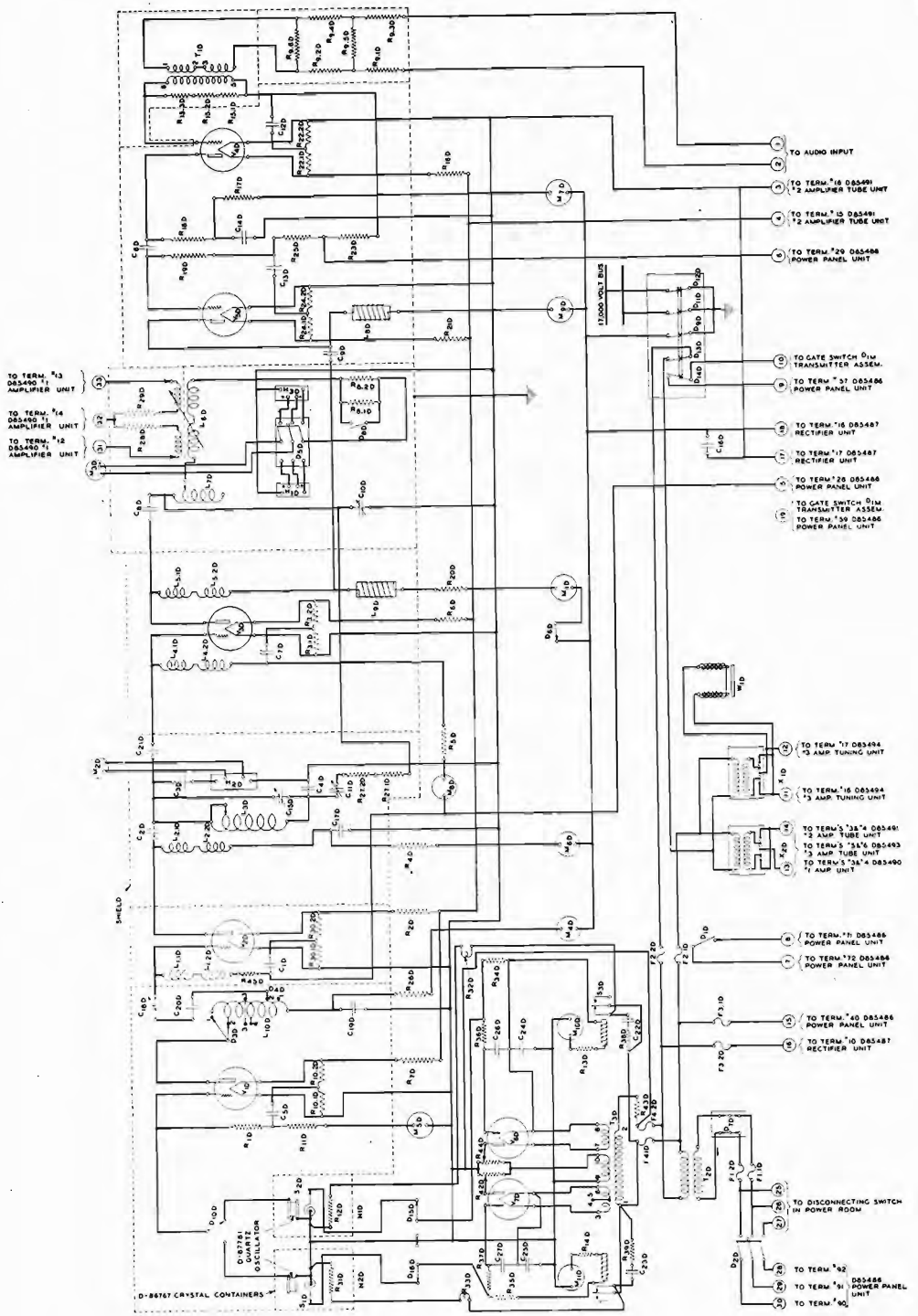
V1D together with one of the quartz oscillators, R1D and R11D and the coil L10D form the oscillator circuit. The magnitude of the radio frequency voltage applied to the quartz oscillator through the tube capacity may be adjusted by means of D3D and the associated plate circuit taps of D10D. Reducing the number of turns included in the plate circuit will reduce the magnitude of the voltage.

The radio frequency voltage applied to V1D is sufficient to cause the grid to go positive with respect to the filament; this causes current to flow in the grid circuit which passes through R1D, R11D and the "OSCILLATOR GRID CURRENT" meter M5D.

Condenser C5D, connected between the junction of R1D and R11D and the mid point of R10.1D and R10.2D, forms in combination with R11D a simple filter circuit which acts to reduce the noise from alternating components of the voltage drop along the filament of V1D. C19D is a radio frequency by-pass condenser for the plate circuit.

The input voltage to the grid of V2D may be varied or controlled by either adjusting the condenser C18D for small variations or by means of D4D and the taps on L10D for larger variations. C20D is a plate voltage stopping condenser.

The tuned output circuit of the radio frequency amplifier V2D is connected to the plate of V2D through the plate voltage stopping condenser C2D. The

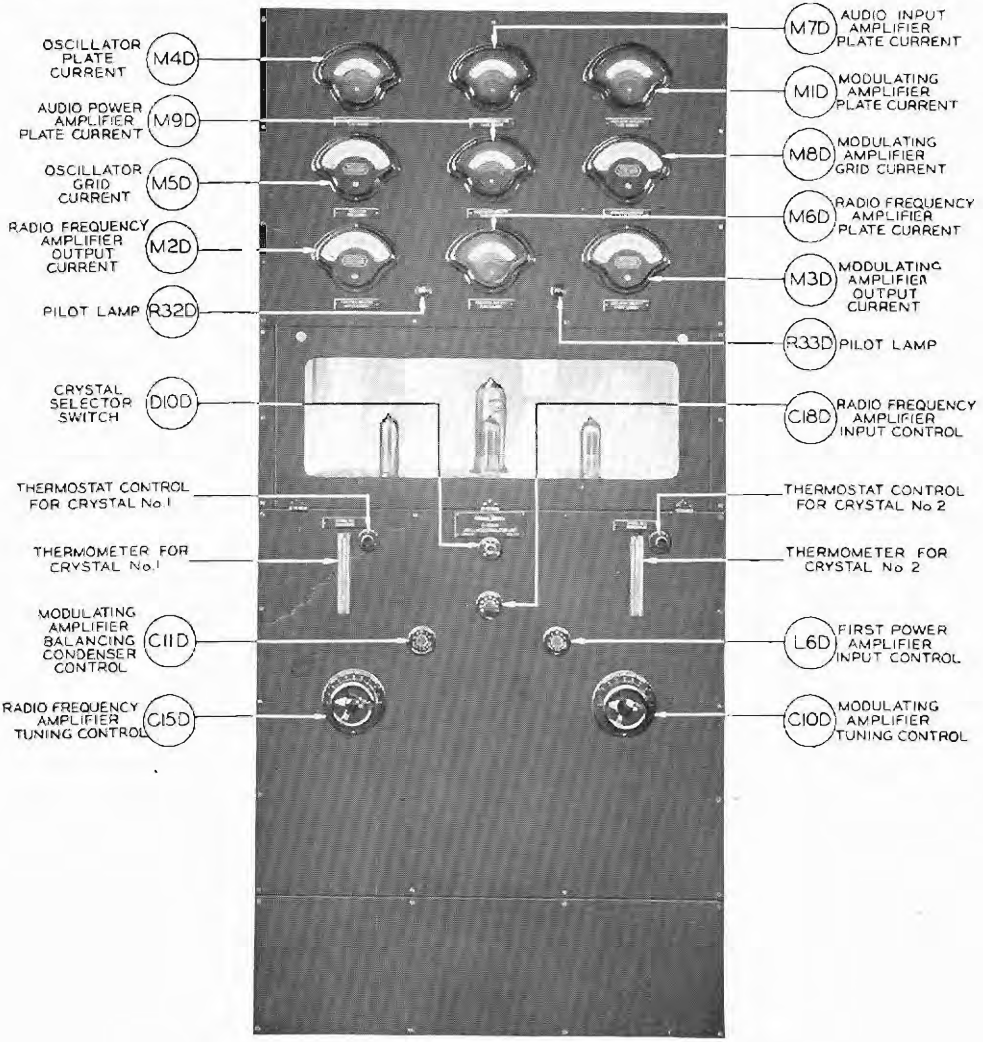


Schematic of No. D-85489 Oscillator Modulator Unit
(See also large diagram in envelope)

tuned circuit consists of coil L3D shunted by the variable condenser C15D and the fixed condensers C3D and C4D. This circuit is adjusted to the desired resonant frequency by moving the variable tap on L3D and by varying the capacity of C15D. The output current of this circuit is measured by the thermocouple H2D in combination with "RADIO FREQ. AMPLIFIER OUTPUT CURRENT" meter M2D.

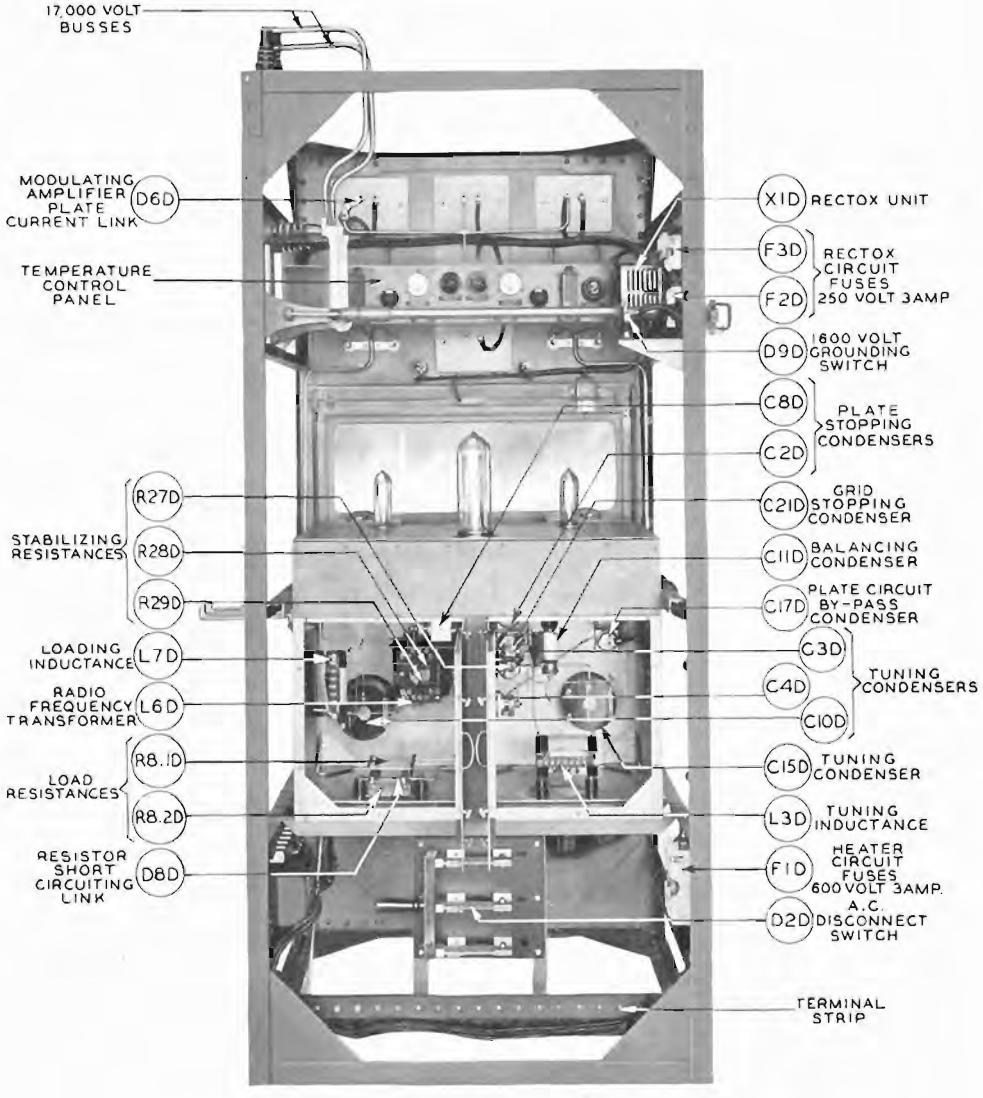
C1D is a radio frequency by-pass condenser for the grid voltage circuit. L1.1D, L1.2D, L2.1D and L2.2D are radio frequency choke coils. C17D is a radio frequency by-pass condenser for the plate circuit.

V3D functions both as a radio frequency amplifier and as a modulator. The carrier frequency impressed on the grid of this tube is modulated in the plate circuit by applying the amplified audio frequency program signal voltage directly to the plate.



No. D-85489 Oscillator Modulator Unit—Front View

The input circuit of V3D is connected to the output circuit of V2D through C21D and through the lead connecting the junction of the H2D and C4D to the radio frequency ground bus. V3D is connected to its output circuit through the plate voltage stopping condenser C8D. The output circuit consists of L7D, the primary windings of the coupling coil L6D, R8.1D and R8.2D and C10D. This circuit is adjusted to resonance by means of the taps on L7D and by varying the capacity of C10D. R8.1D and R8.2D are placed in this circuit for the purpose of broadening its resonant frequency characteristic. The output current is measured by the thermocouple H3D and its associated meter M3D.

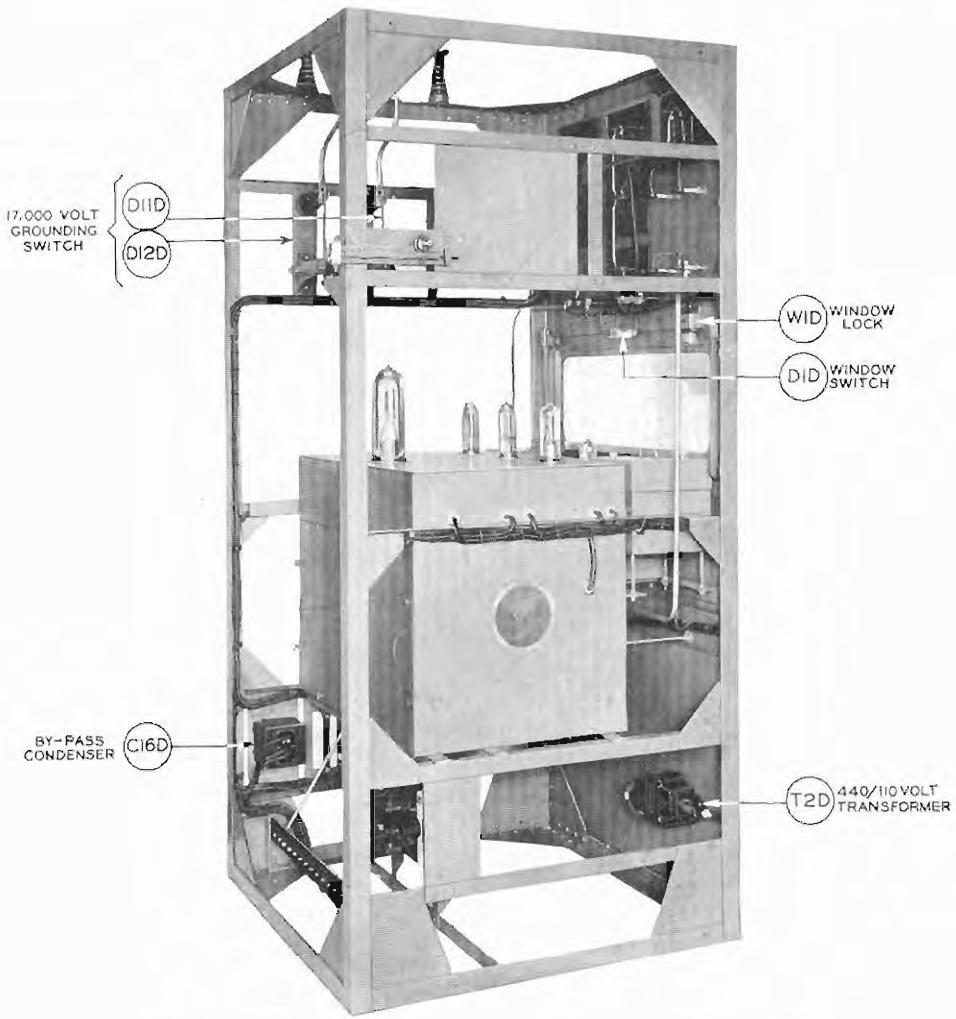


No. D-85489 Oscillator Modulator Unit—Rear View

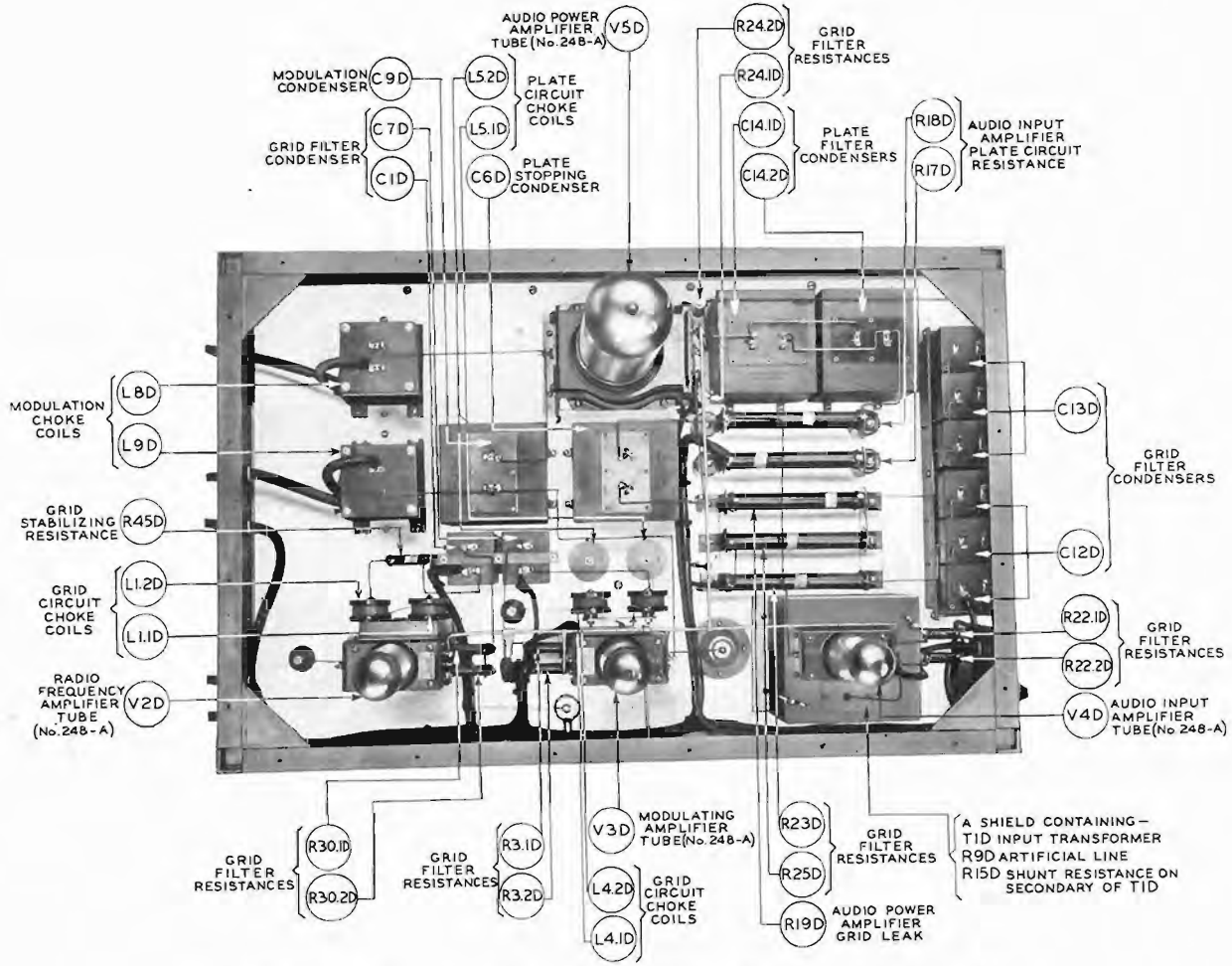
The modulating amplifier V3D is neutralized by condenser C11D. R27.1D and R27.2D are to prevent interstage singing.

When the circuit is being neutralized R8.1D and R8.2D are shorted by the removable link D8D and the low current thermocouple H1D is placed in the circuit by means of D5D which also connects to H3D. L4.1D and L4.2D are radio frequency current chokes in the grid bias circuit and C7D is a radio frequency by-pass condenser for this circuit.

The plate circuit chokes L5.1D and L5.2D are in series with the plate voltage supply circuit to V3D. [redacted]

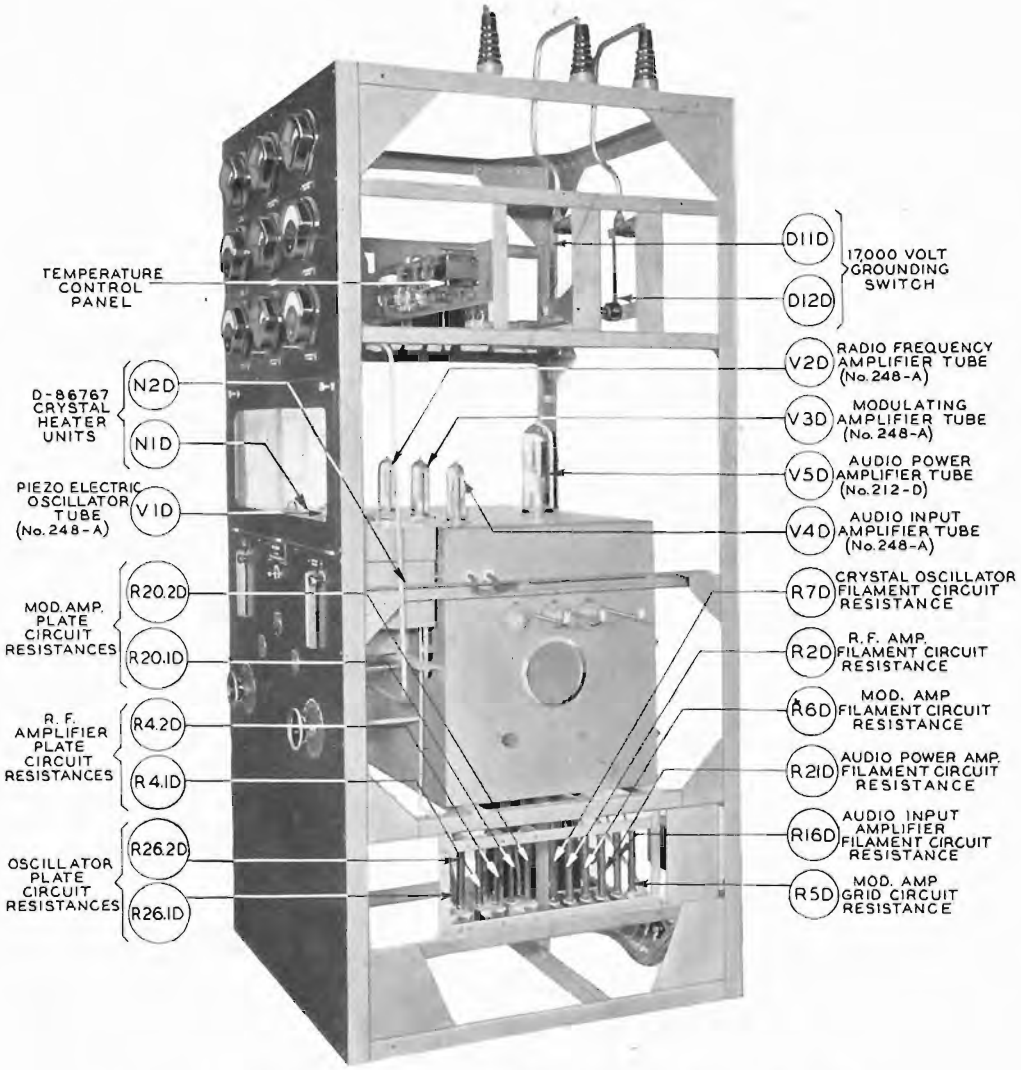


No. D-85489 Oscillator Modulator Unit—Left Side View

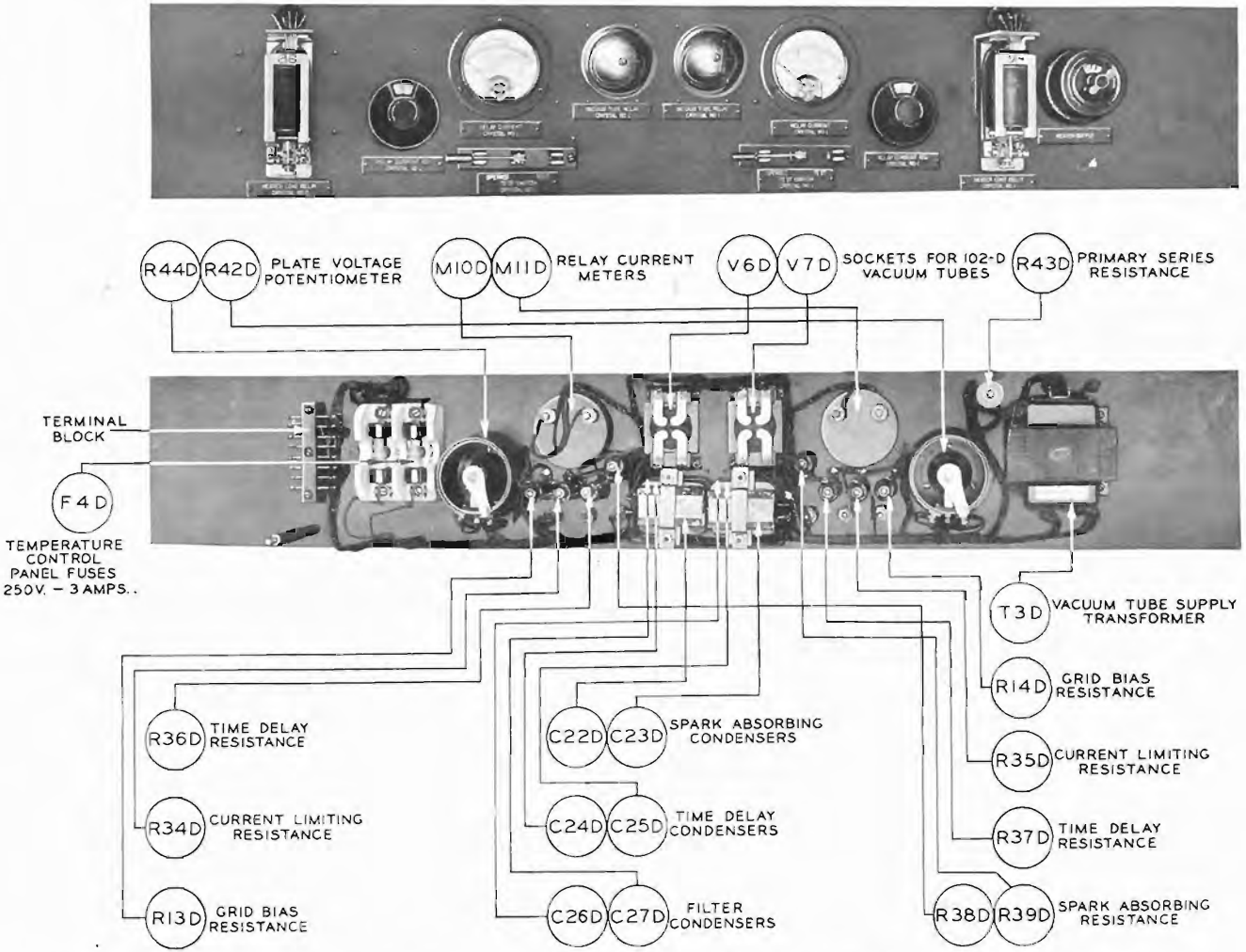


No. D-85489 Oscillator Modulator Unit—Tube Shelf—Top View

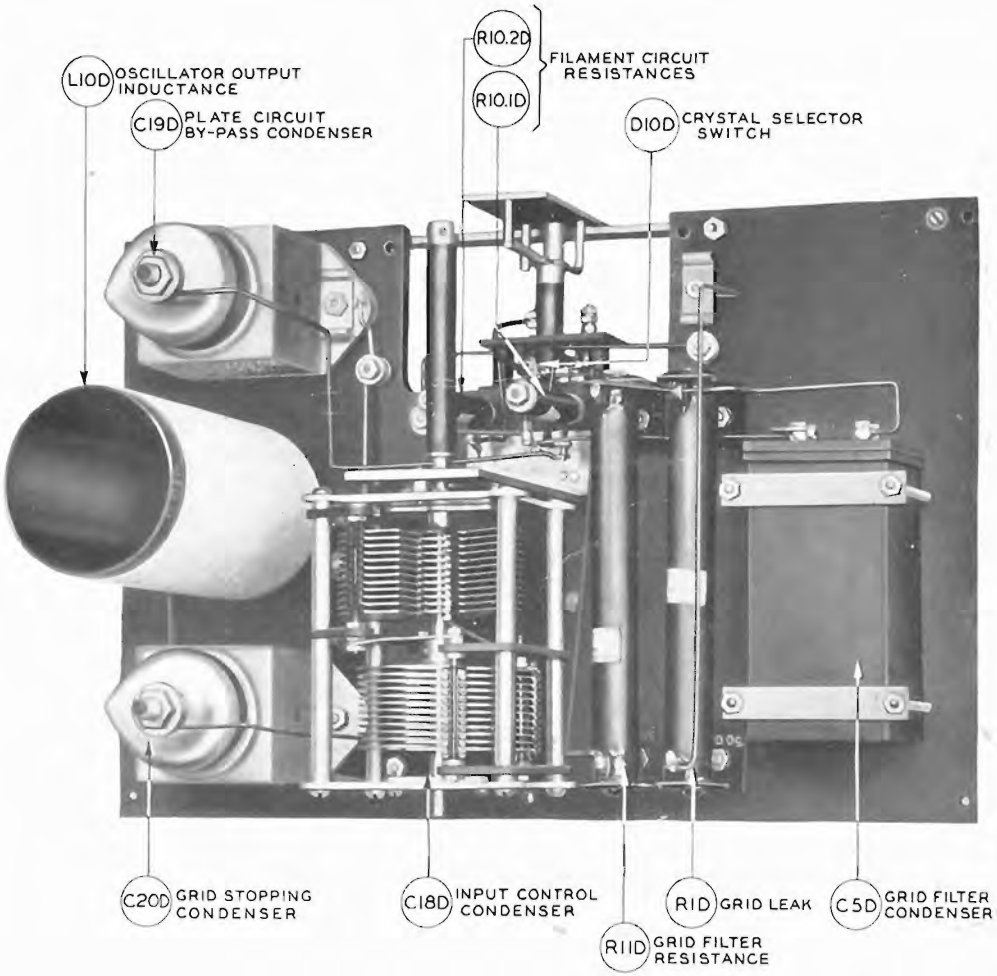
The audio frequency circuit is essentially a two-stage amplifier which includes the tubes V4D and V5D. The resistances R9D, form a pad which is used for the purpose of reducing the amplitude of the input audio signal to a desired level. T1D is the audio input transformer for the amplifier. R18D is the plate circuit load resistance for V4D. Grid bias for V5D is supplied through R19D. C12D, C14D and C13D act as audio by-pass condensers. C6D is the coupling condenser between the plate of V4D and the grid of V5D. C9D connects the output of V5D to the plate circuit of V3D.



No. D-85489 Oscillator Modulator Unit—Right Side View

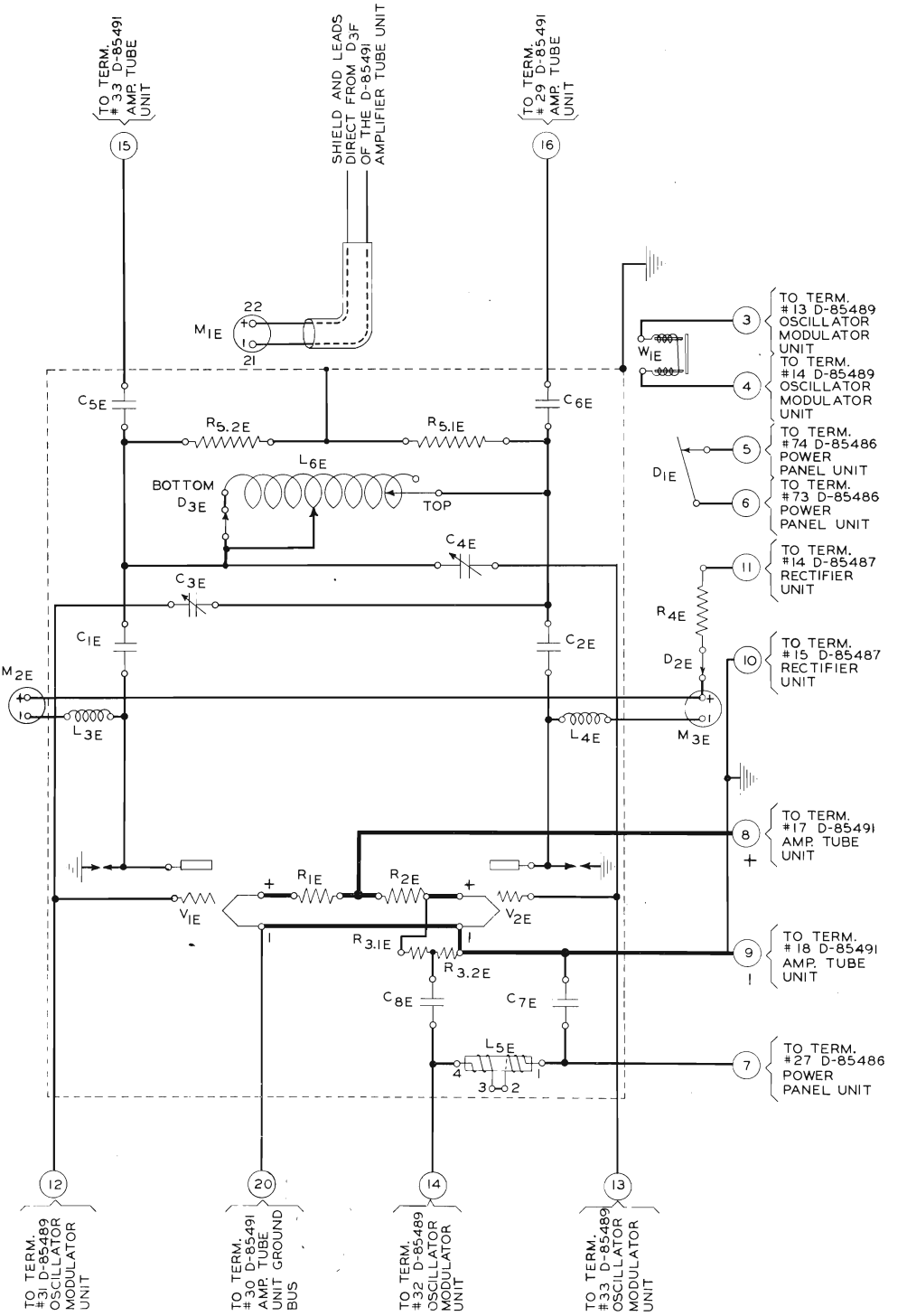


No. D-85489 Oscillator Modulator Unit—Temperature Control Panel—Front and Rear Views



No. D-85489 Oscillator Modulator Unit—Crystal Oscillator Panel—Bottom View

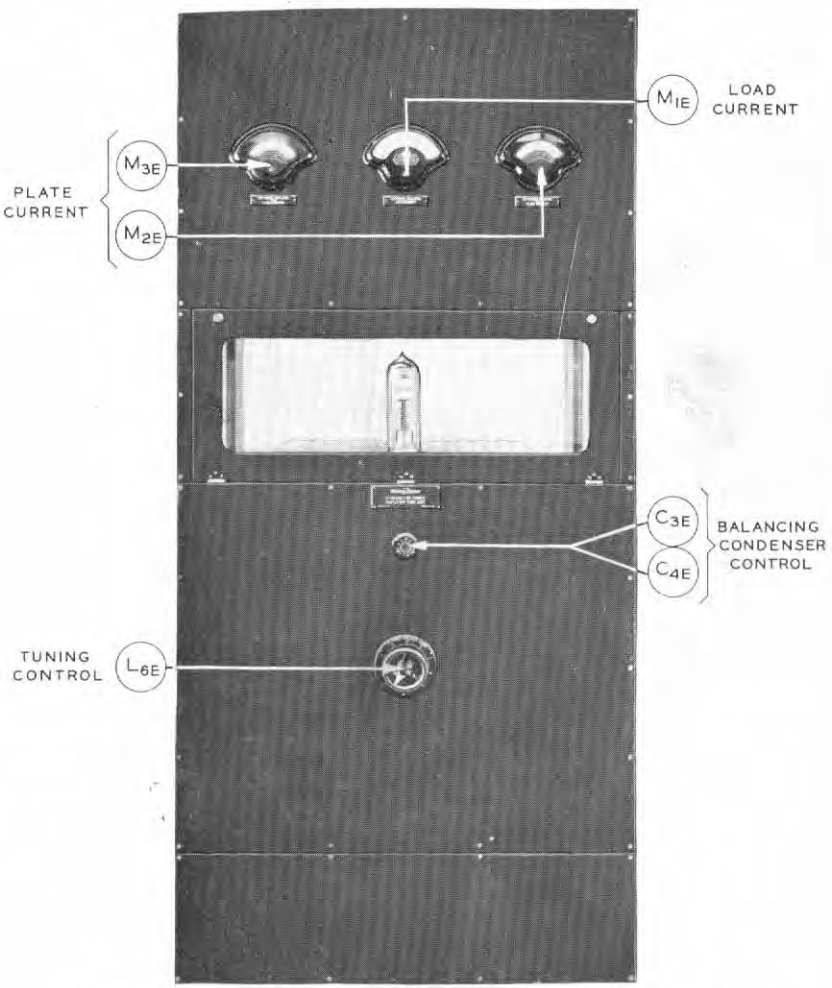
Note: Labels "R11D—Grid Filter Resistance" and "R1D—Grid Leak" should be interchanged.



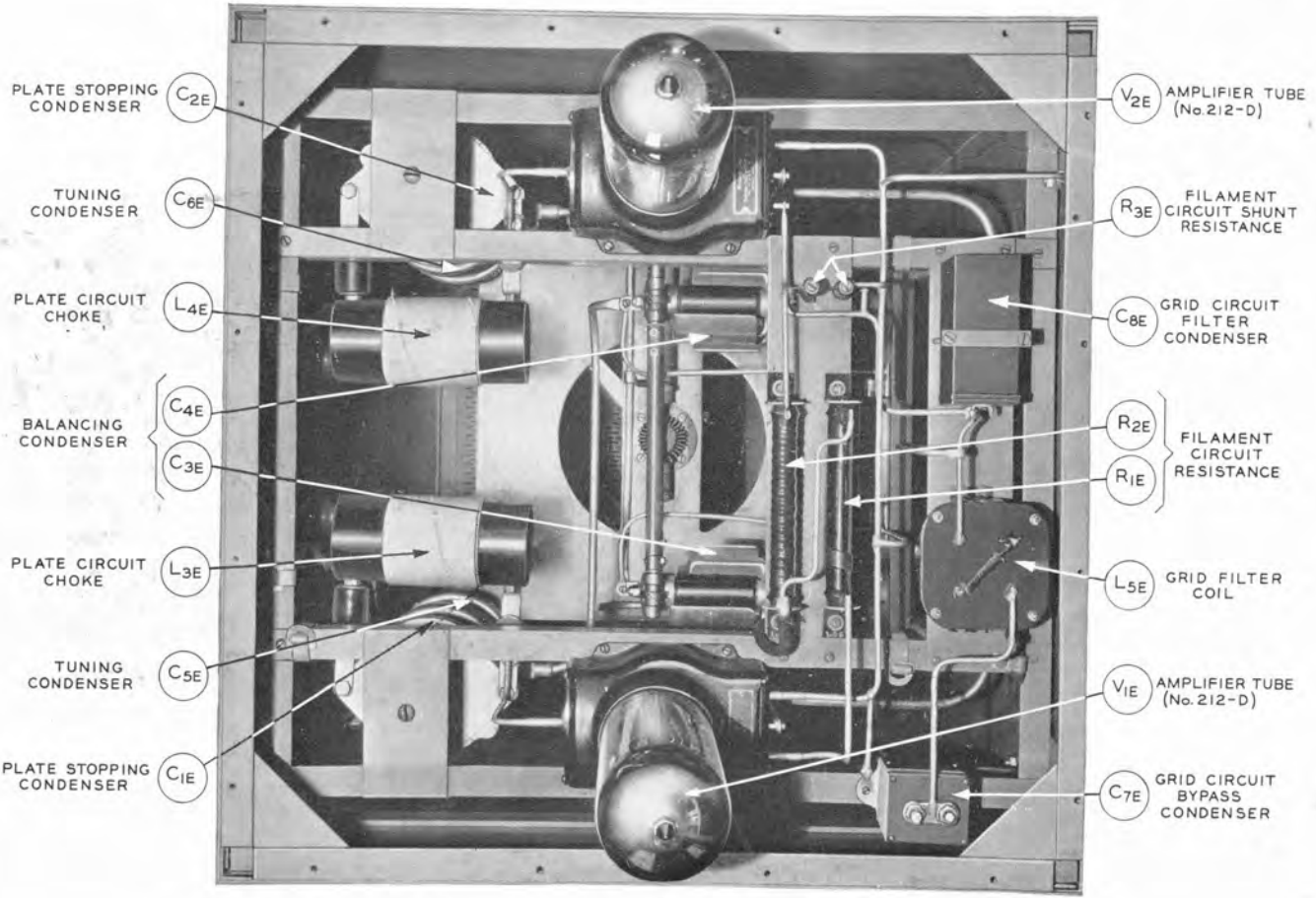
Schematic of No. D-85490 First Power Amplifier Unit

No. D-85490 First Amplifier Unit and No. D-85491 Second Power Amplifier Tube Unit.

The First Power Amplifier Unit has a neutralized push-pull circuit in which the grid circuit of V1E and V2E is coupled to the tuned output circuit of the modulating amplifier tube V3D by means of the secondary winding of the coupling coils L6D. C8E is a by-pass condenser for the grid bias circuit. The tuned output circuit of the First Power Amplifier is located partly in the No. D-85490 First Power Amplifier Unit and partly in the No. D-85491 Second Power Amplifier Tube Unit. The output circuit is connected to the plates of V1E and V2E through the plate voltage stopping condensers C1E and C2E. The following elements are included in the tuned circuit: L6E, C5E, C6F, C5F, C10F, C9F, and C6E. The tuned circuit is approximately adjusted to resonate at the particular frequency of the oscillator by adjusting the position of the clip on L6E and shorting the end turns of the coil by means of D3E. Fine adjustment of the



No. D-85490 First Power Amplifier Unit—Front View



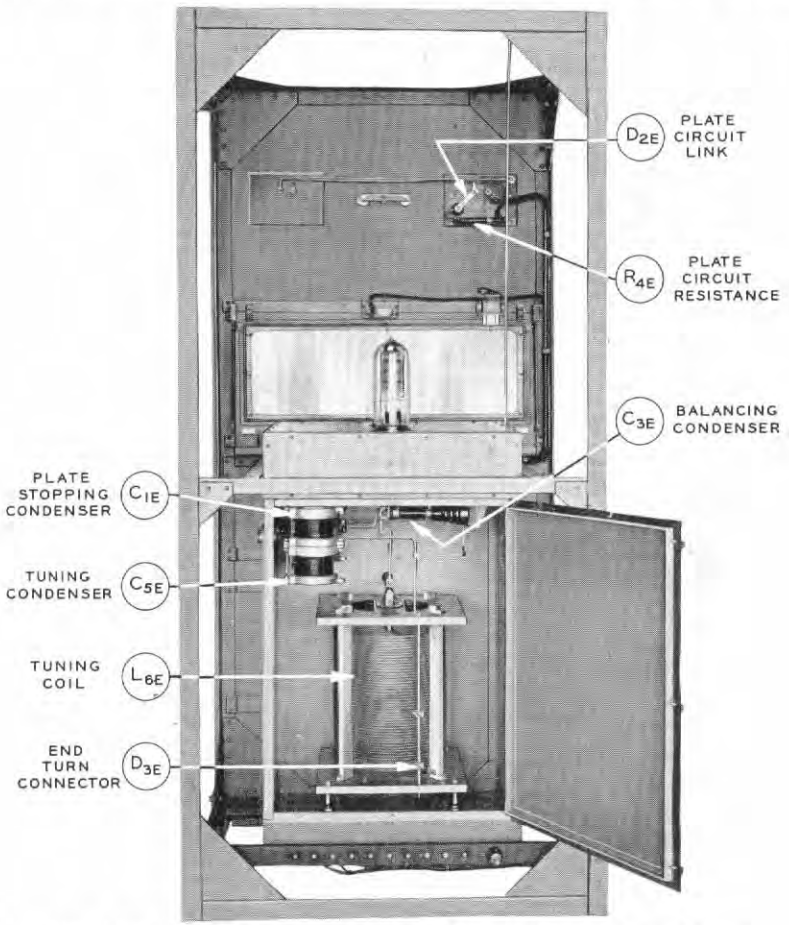
No. D-85490 First Power Amplifier Unit—Top View—Screen Removed

inductance of L6E is obtained by a sliding contact on an end turn of the coil. The resonant characteristic of the tuned circuit is broadened by R6F and R5F which shunt the condensers C5F and C10F. The load current through R6F is measured by means of the thermocouple H1F and M1E when the latter is connected to H1F by D3F. When it is desired to neutralize the First Power Amplifier the low current thermocouple H2F is connected in series with the resonant circuit by means of D3F.

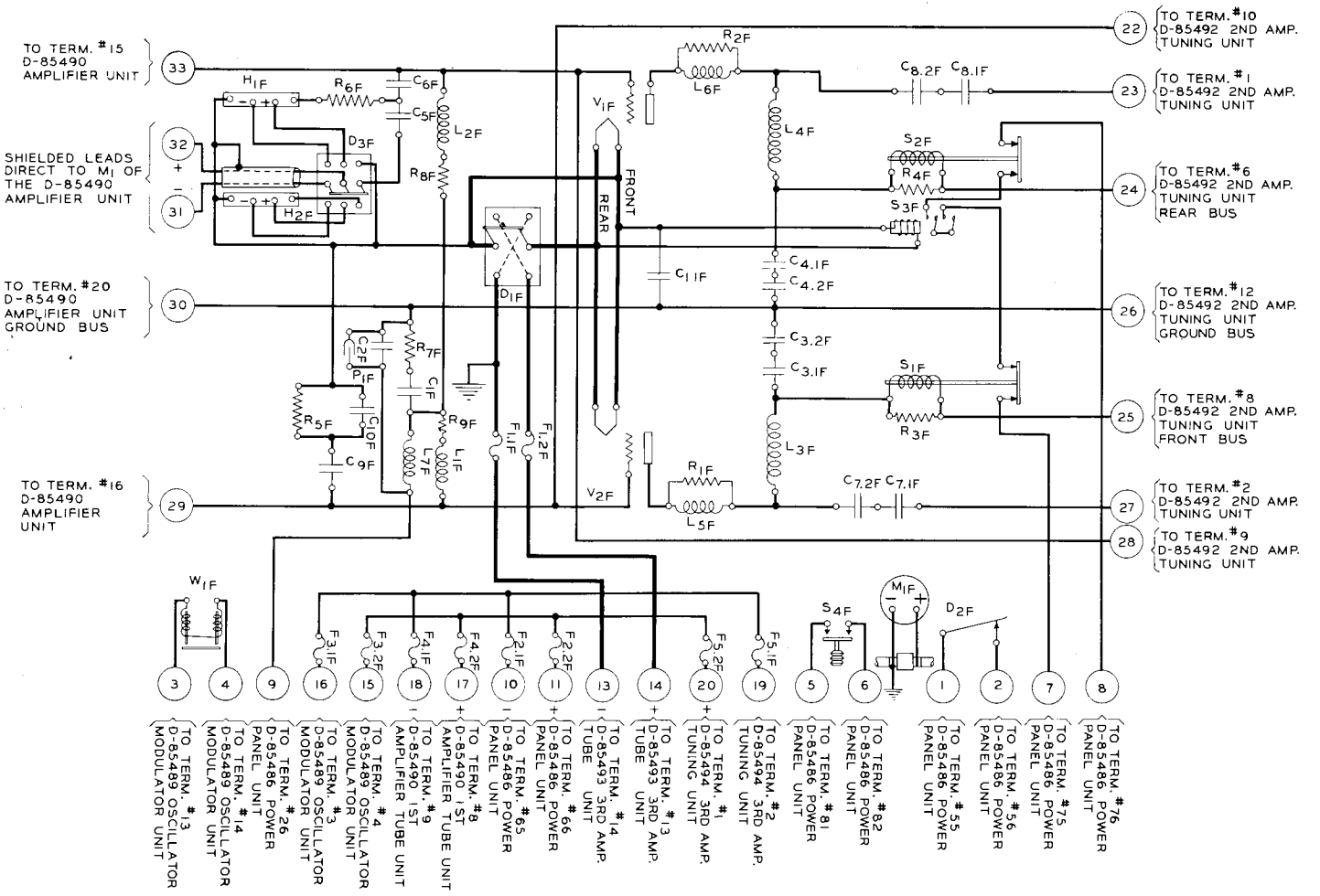
The circuit is neutralized by C3E and C4E. The capacities of C3E and C4E are controlled simultaneously by means of a common control shaft.

R5.2E and R5.1E connected across the output circuit with their mid-point connected to the radio frequency ground bus are used for the purpose of draining to ground any charges that may accumulate on C1E, C5E, C2E, and C6E from the plate voltage.

The junction point of R3.1E and R3.2E, which are connected across the filaments, is used as a means of effectively connecting the by-pass condenser to the center of the filament. The protective spark gaps marked G between the



No. D-85490 First Power Amplifier Unit—Rear View



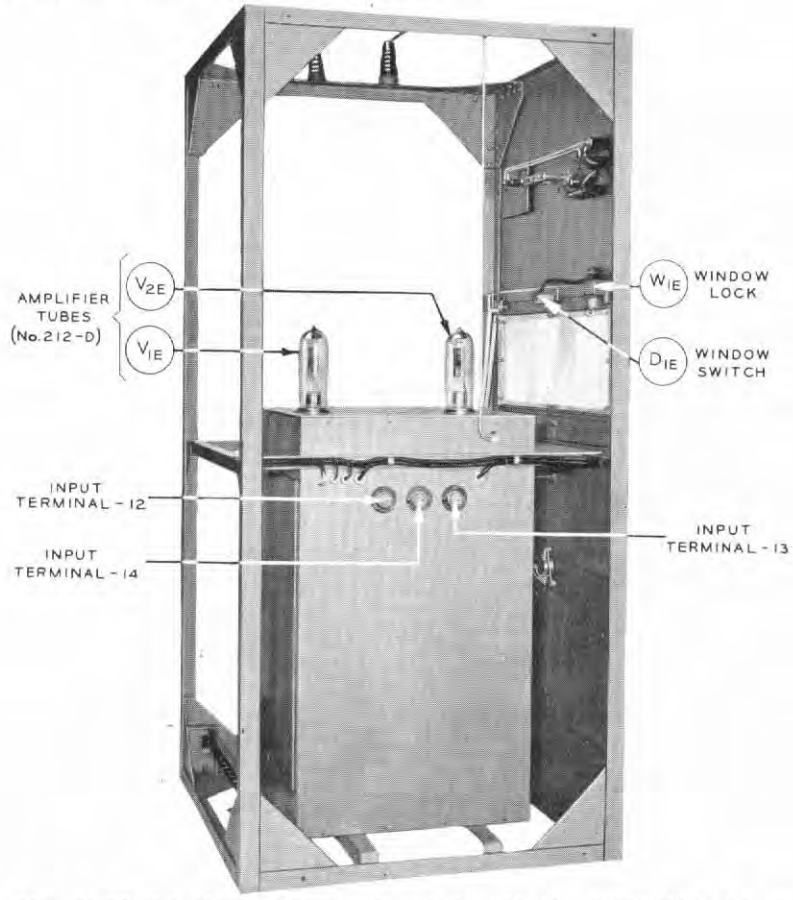
Schematic of No. D-85491 Second Power Amplifier Tube Unit

plates of V1E and V2E and a ground connection protect these tubes from excessive voltage surges resulting from abnormal circuit conditions. These spark gaps are in the tube sockets.

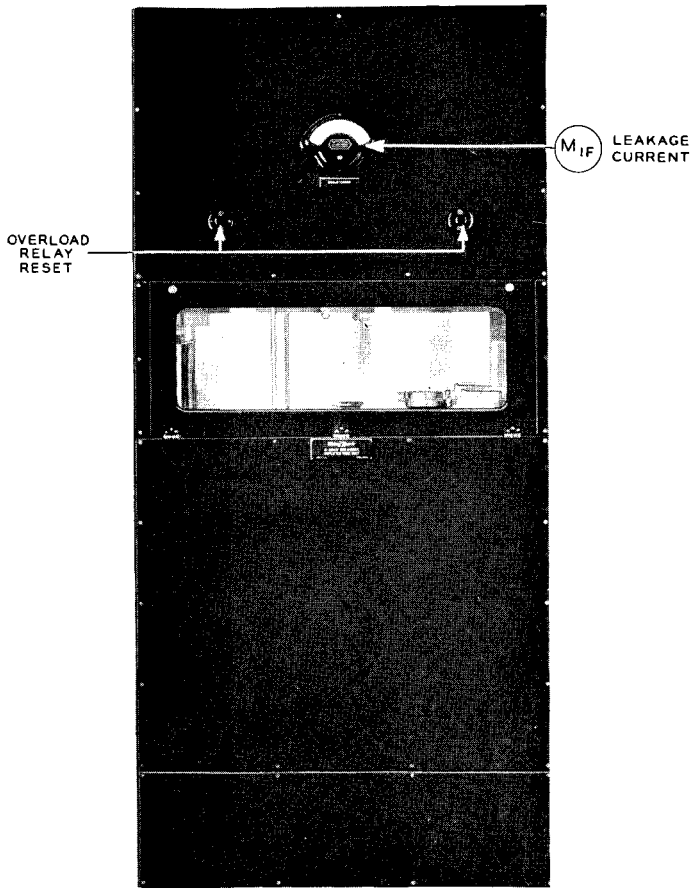
The circuit of the Second Power Amplifier is a neutralized push-pull circuit using two water-cooled power tubes V1F and V2F. The tubes of the Second Power Amplifier are located in the No. D-85491 Second Power Amplifier Tube Unit. The grid circuits of V1F and V2F are protected against parasitic singing by R8F and R9F and by C1F in series with R7E connected between the junction point of R8F and R9F and the radio frequency ground bus. C11F between the filaments of V1F and V2F, and the ground bus is a radio frequency by-pass condenser, which makes the filament circuit effectively at ground potential for radio frequency currents.

V1F and V2F are connected to the tuned circuit through the anti-sing units L6F-R2F, and L5F-R1F, and the plate voltage stopping condensers C8.2F, C8.1F and C7.2F, C7.1F.

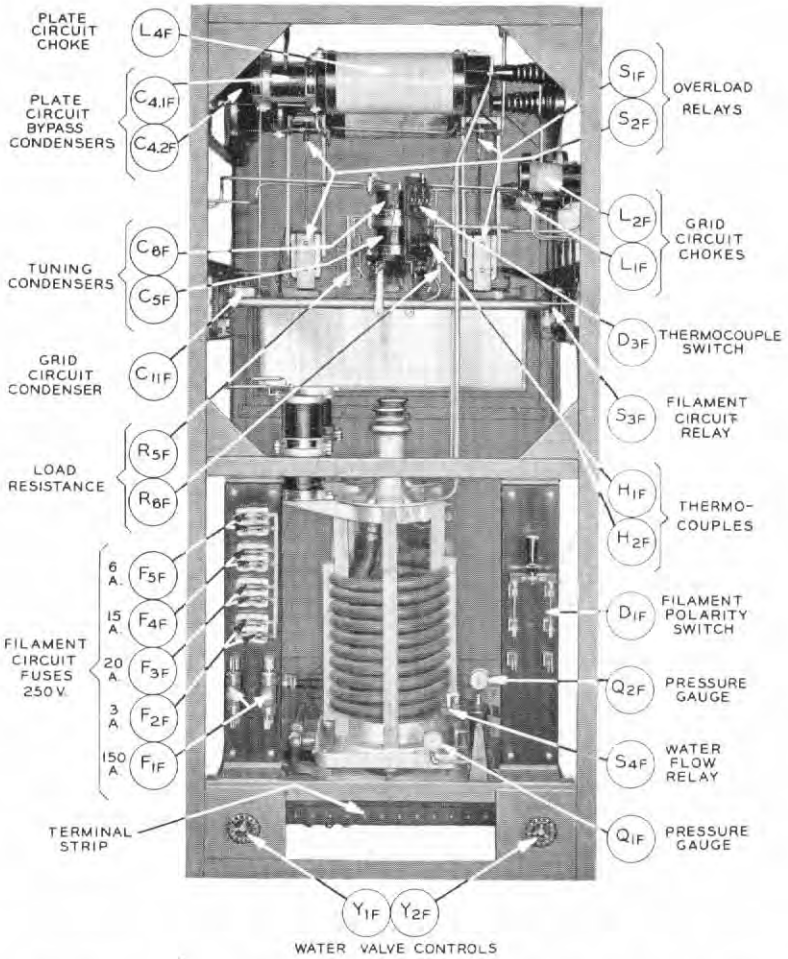
The plate voltage supply is connected to V1F and V2F through choke coils L3F and L4F. C3.1F, C3.2F and C4.1F, C4.2F act as radio frequency by-pass condensers for the plate voltage supply circuit.



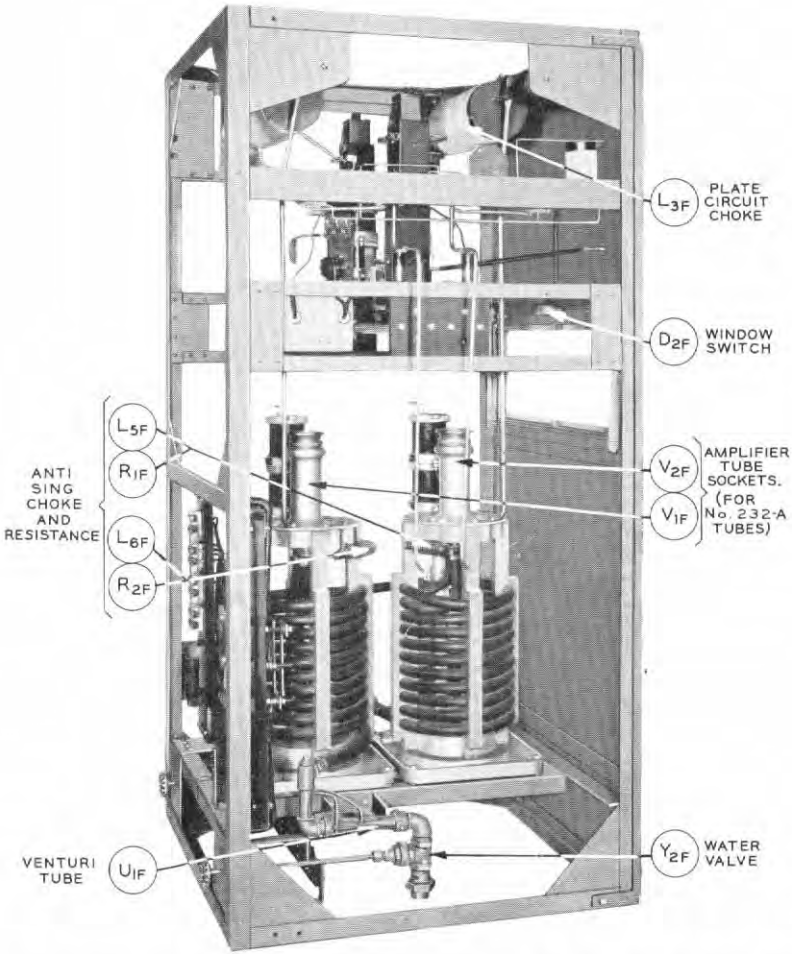
No. D-85490 First Power Amplifier Unit—Left Side View



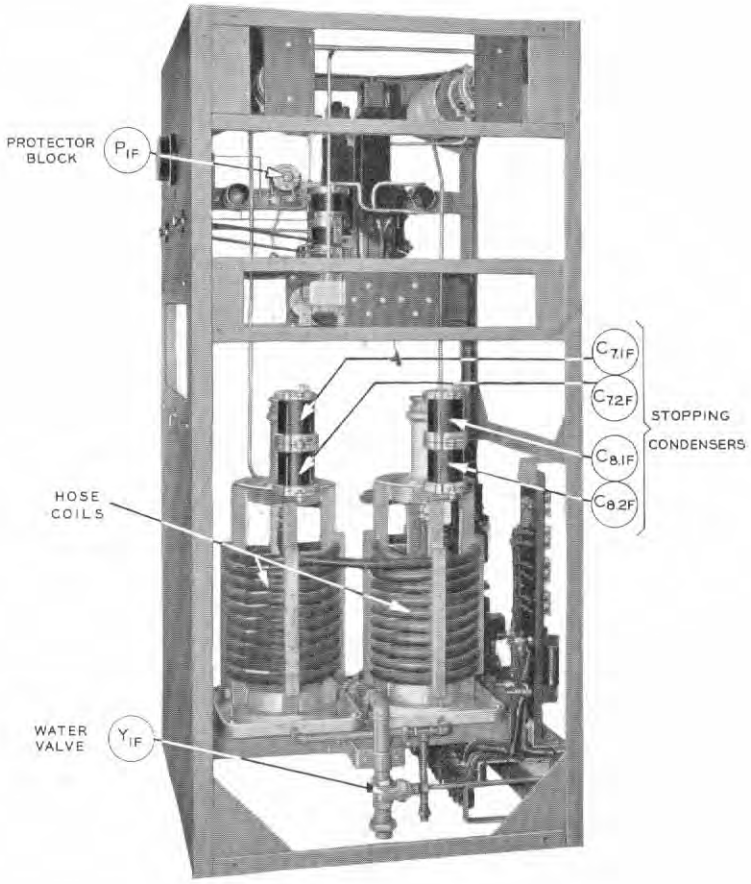
No. D-85491 Second Power Amplifier Tube Unit—Front View



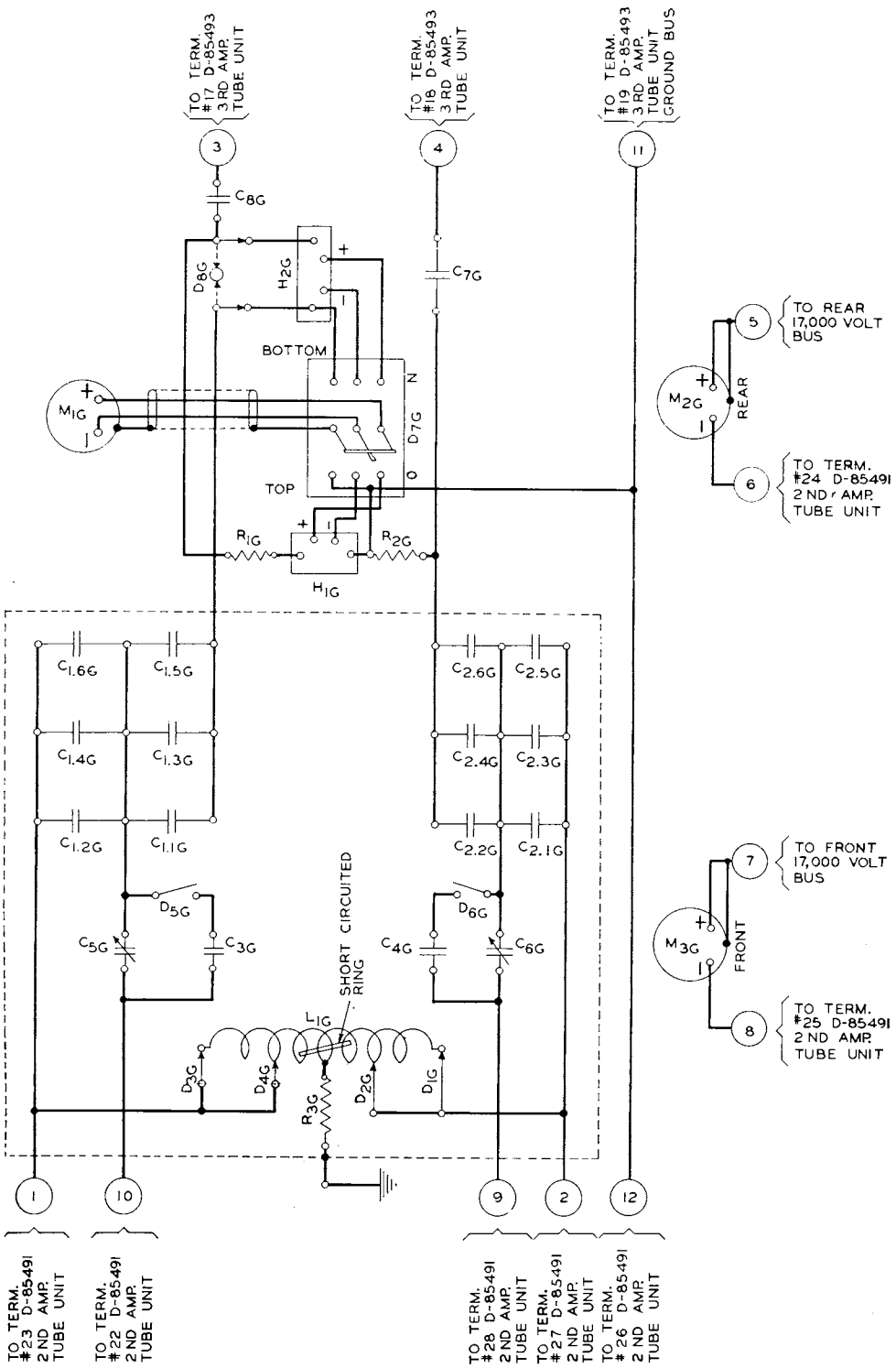
No. D-85491 Second Power Amplifier Tube Unit—Rear View



No. D-85491 Second Power Amplifier Tube Unit—Left Side View



No. D-85491 Second Power Amplifier Tube Unit—Right Side View



Schematic of No. D-85492 Second Power Amplifier Tuning Unit

No. D-85492 Second Power Amplifier Tuning Unit and No. D-85493 Third Power Amplifier Tube Unit.

The apparatus of the tuned circuit of the second power amplifier is located partly in the No. D-85492 Second Power Amplifier Tuning Unit and partly in the No. D-85493 Third Power Amplifier Tube Unit. The tuned circuit includes the coil L1G and a circuit which consists essentially of 6 condenser combinations connected in series, these are the condensers C1G, C8G, C5H, C6H, C7G, and C2G. In some cases several condenser units are connected in parallel as indicated by the designations on the schematic.

The output circuit is tuned approximately to resonance by adjusting the movable clips D2G and D4G on L1G. The dead end turns of L1G are shorted by D1G and D3G. The fine tuning adjustment of L1G is obtained by turning the closed ring which is placed inside, at the center, of the turns of L1G.

The current in the tuned circuit is measured by means of the thermocouple H2G and the meter M1G connected to it by means of D7G. H2G may be placed in the circuit or removed from it by means of the movable links D8G.

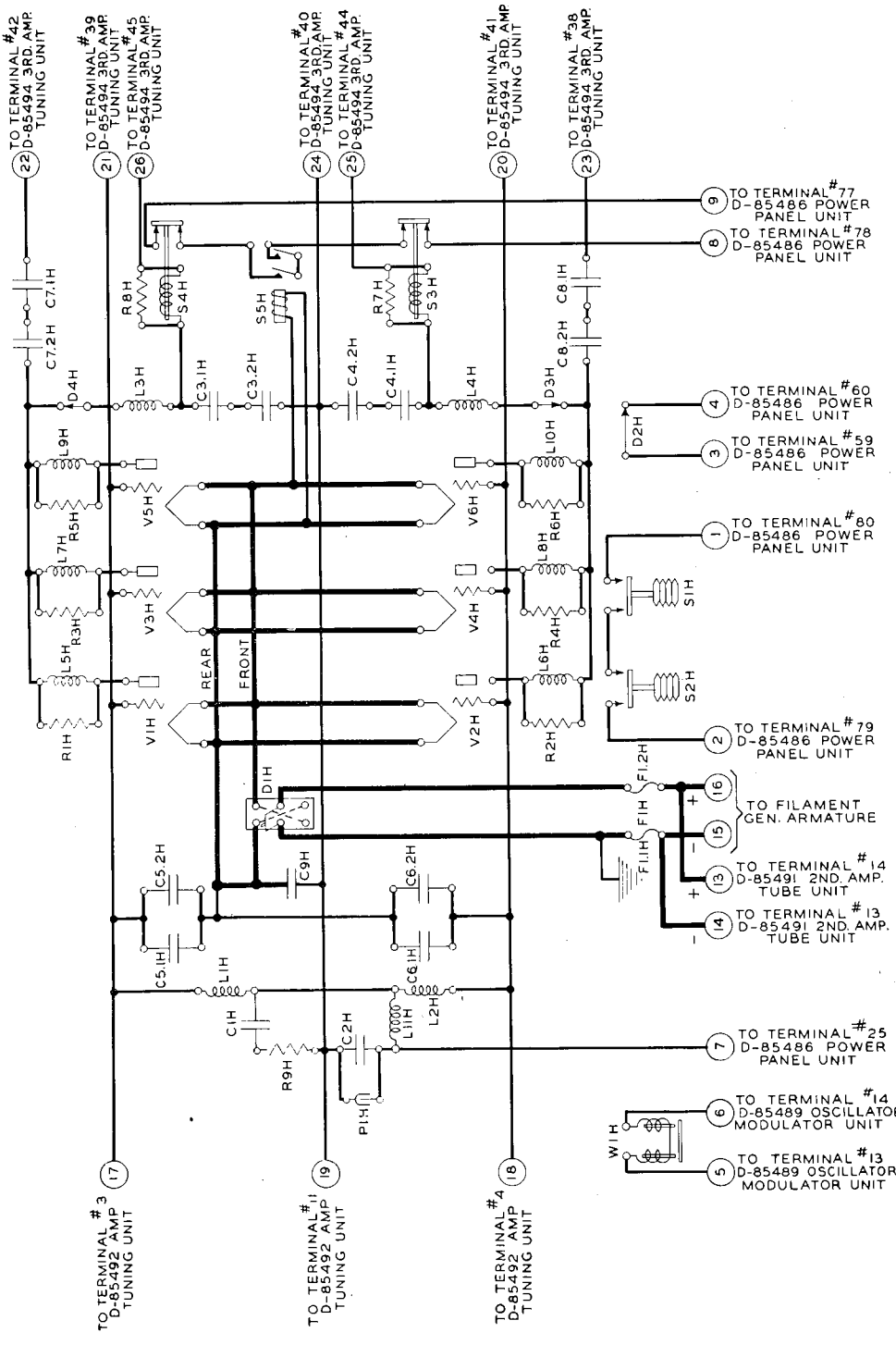
Resistances R1G and R2G form a load for this amplifier. The current through this load is measured by meter M1G when it is connected to thermocouple H1G by means of switch D7G. R3G connected between the mid-point of L1G and ground acts as a drain for charges from the high voltage plate supply that may accumulate on the condensers connected to the outer terminals of L1G.

The Second Power Amplifier is neutralized by means of C5G and C6G. The capacitances of C5G and C6G are varied simultaneously by means of a common shaft control. The neutralizing capacity is increased by adding the capacitance of C3G and C4G when the disconnect links D5G and D6G are closed. When the second power amplifier circuit is being neutralized the low current thermocouple H2G is connected in series with the resonant circuit by means of the links D8G, and the time meter M1G is connected to thermocouple H2G switch D7G.

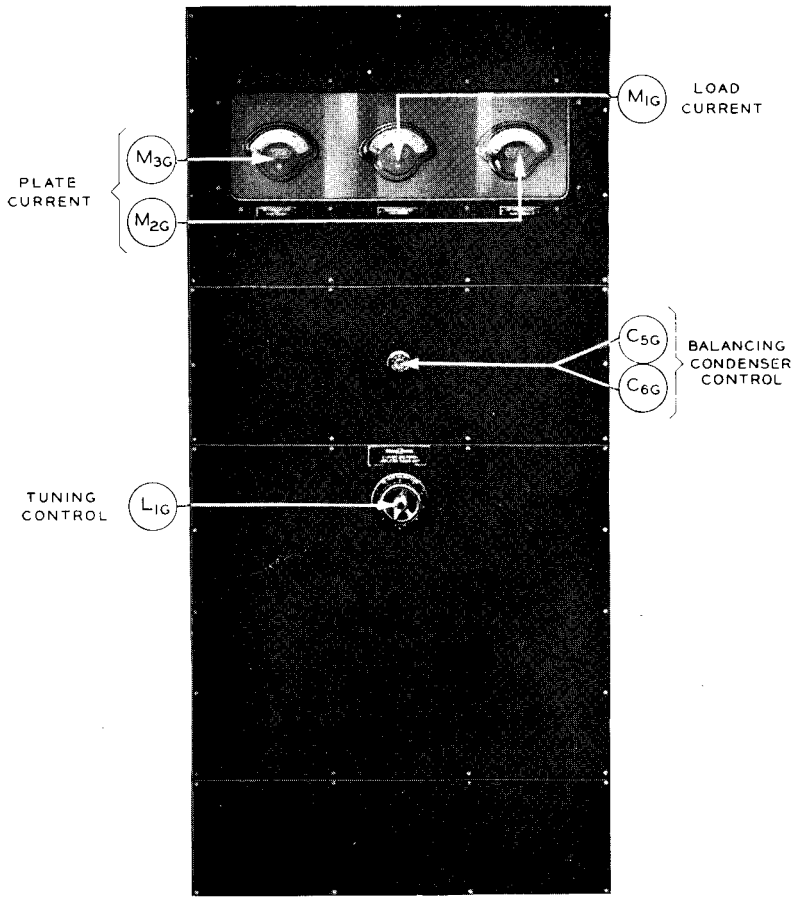
The Third Power Amplifier is a neutralized push-pull amplifier circuit in which two groups of three water-cooled power tubes V1H, V3H, V5H and V2H, V4H, V6H connected in parallel are used. The tube apparatus is located in the No. D-85493 Third Power Amplifier Tube Unit and the tuned circuit is located in the No. D-85494 Third Power Amplifier Tuning Unit adjacent to it.

C9H connected between the filament circuit of the Third Power Amplifier tubes and the ground bus is a radio frequency by-pass condenser which effectively grounds these circuits for radio frequency current. The tubes of the third power amplifier are connected to the tuned circuit through the anti-sing units L5H-R1H, L7H-R3H, L9H-R5H, and L6H-R2H, L8H-R4H, L10H-R6H and through the plate voltage stopping condensers C7.1H, C7.2H and C8.1H, C8.2H.

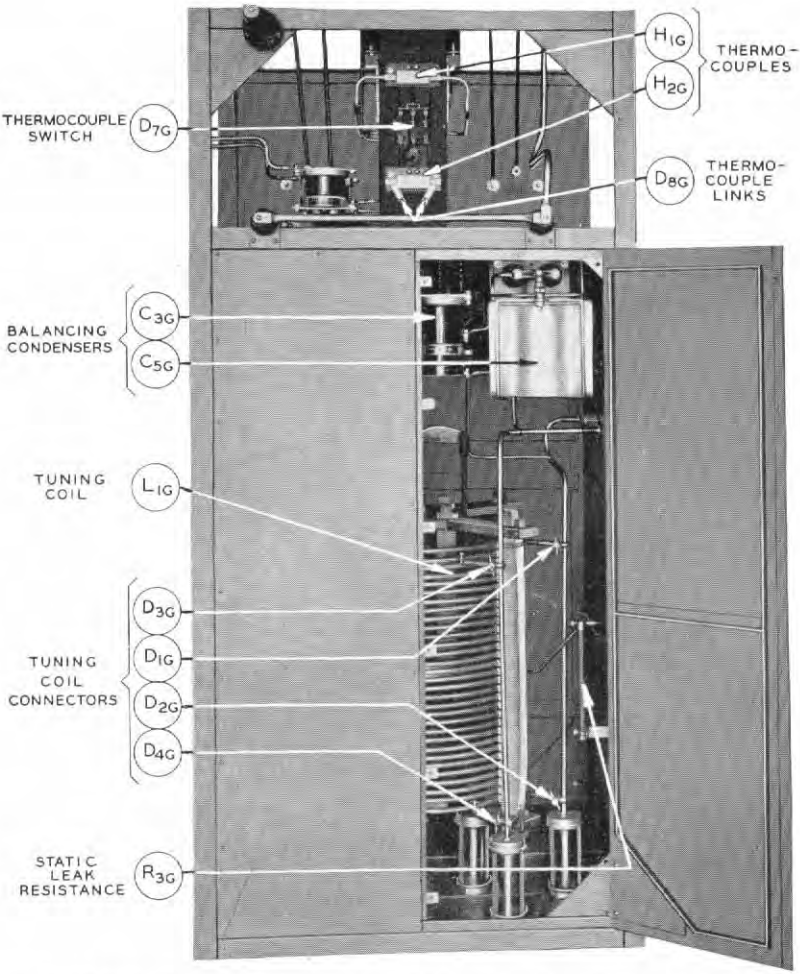
The plate voltage supply circuit is connected to V1H, V3H and V5H through the choke coil L3H, the disconnect switch D4H and the coils of the anti-sing units, and similarly, it is connected to the plates of V2H, V4H and V6H through L4H, D3H and the coils of the anti-sing units. C3.1H, C3.2H and C4.2H, C4.1H act as radio frequency by-pass condensers for plate voltage supply circuit.



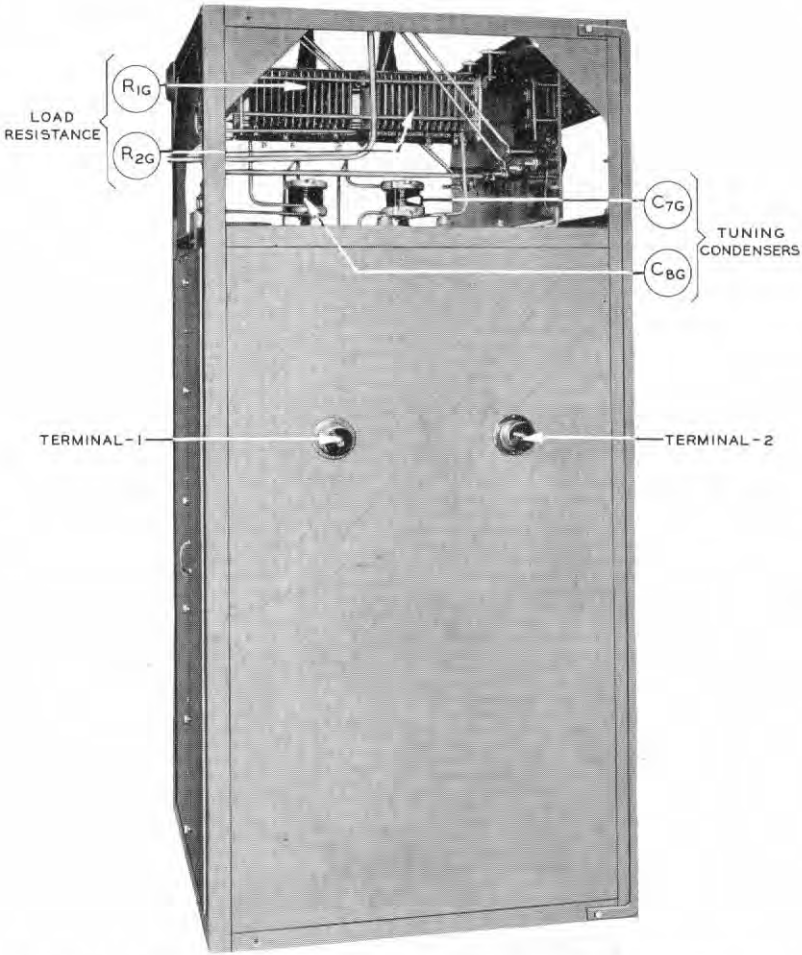
Schematic of No. D-85493 Third Power Amplifier Tube Unit



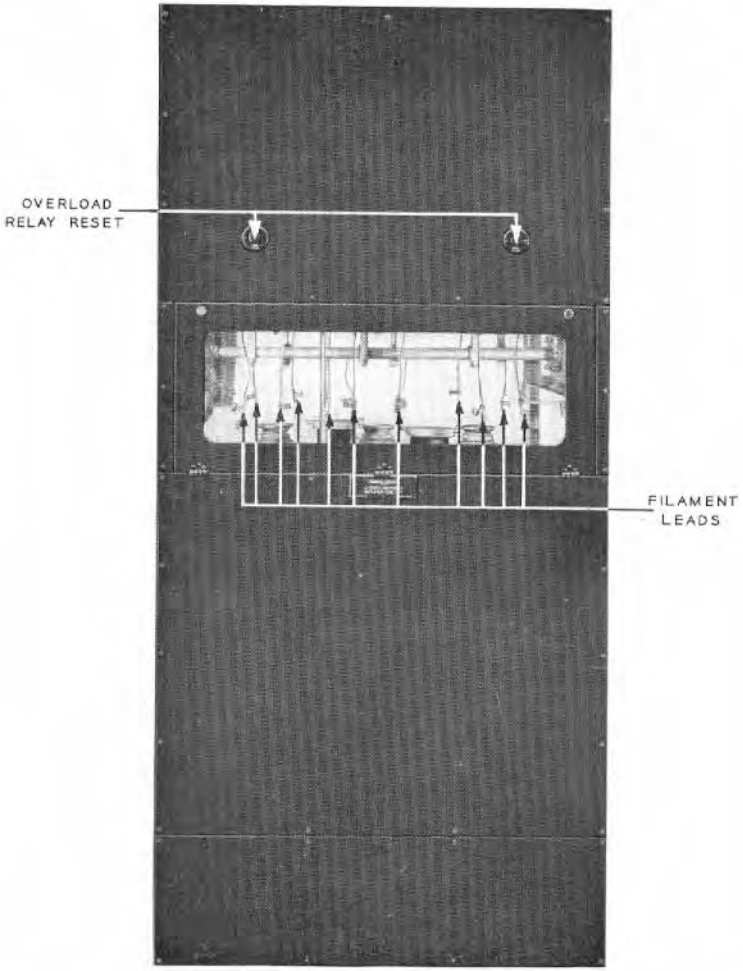
No. D-85492 Second Power Amplifier Tuning Unit—Front View



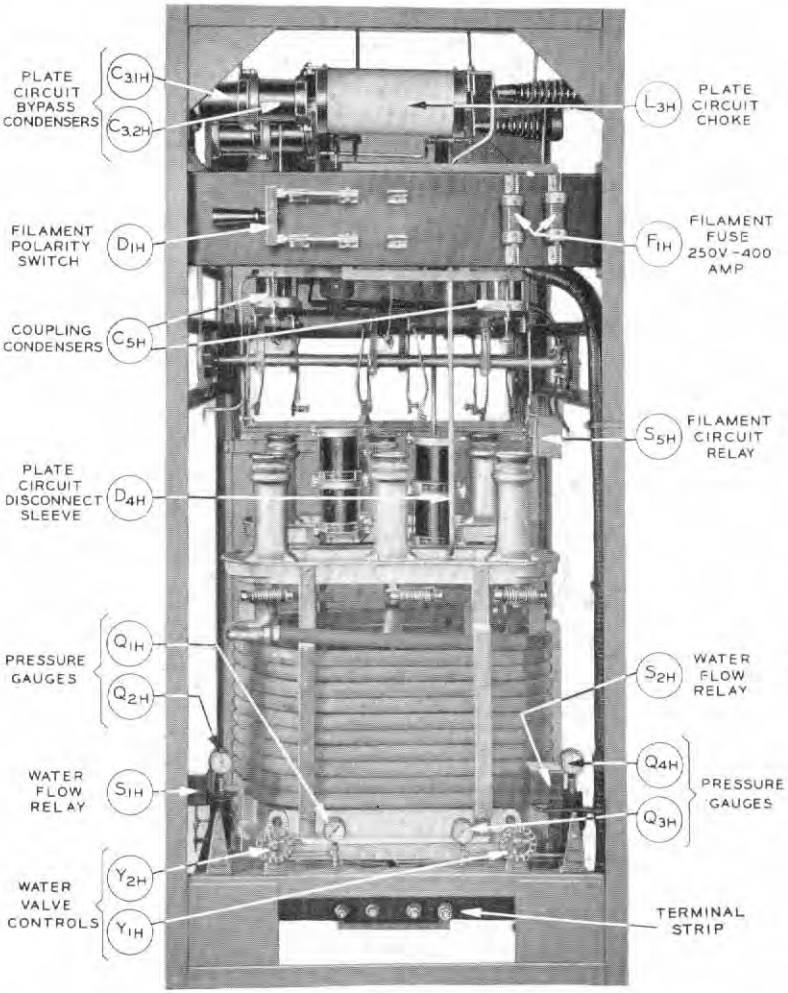
No. D-85492 Second Power Amplifier Tuning Unit—Rear View



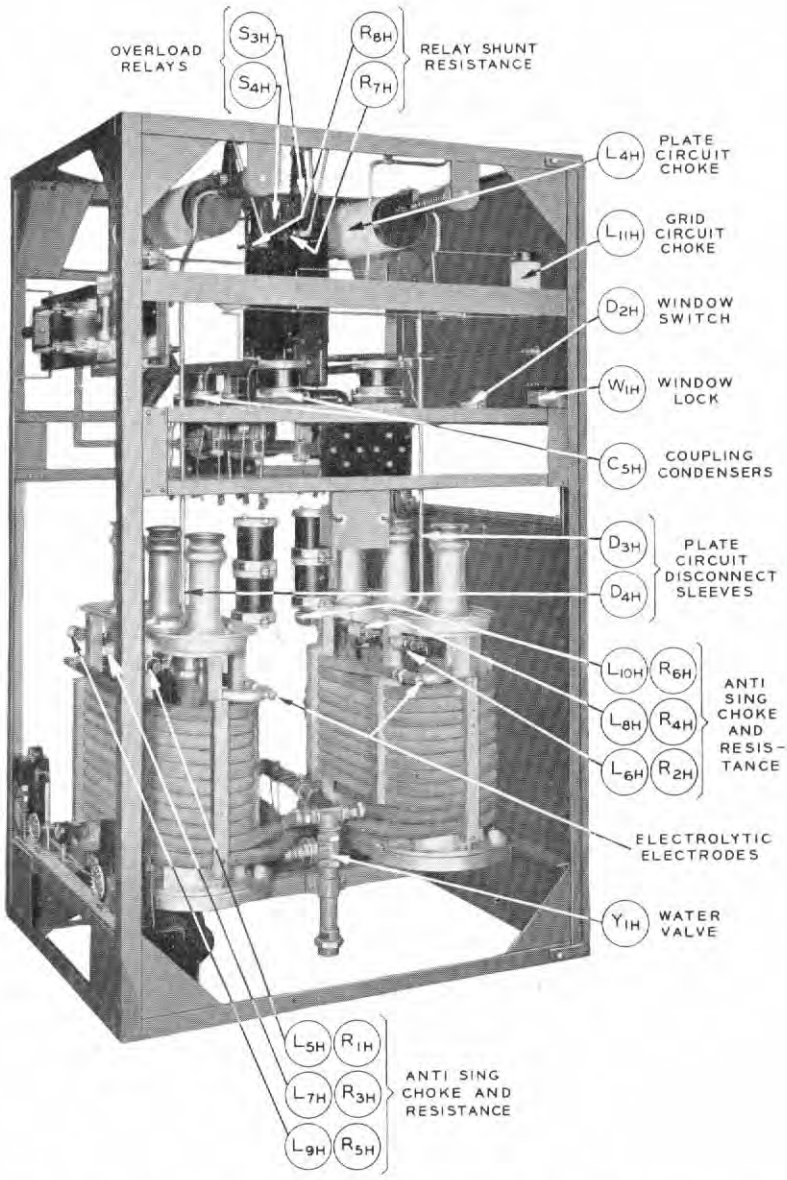
No. D-85492 Second Power Amplifier Tuning Unit—Left Side View



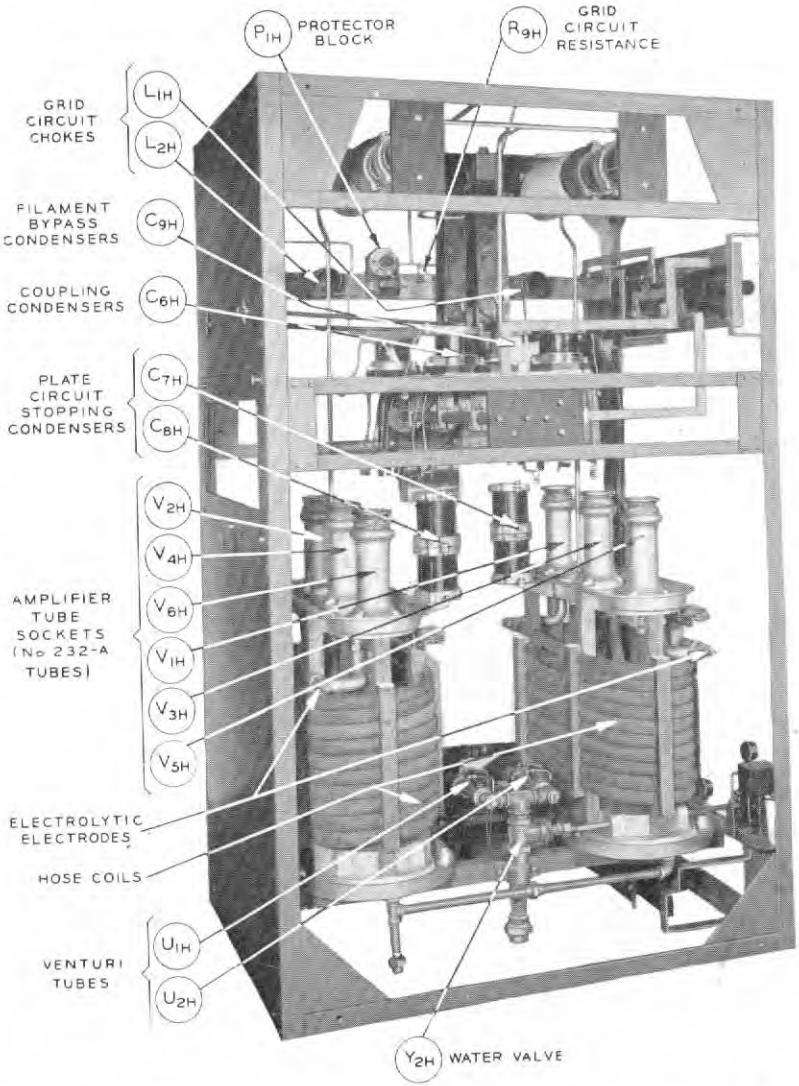
No. D-85493 Third Power Amplifier Tube Unit—Front View



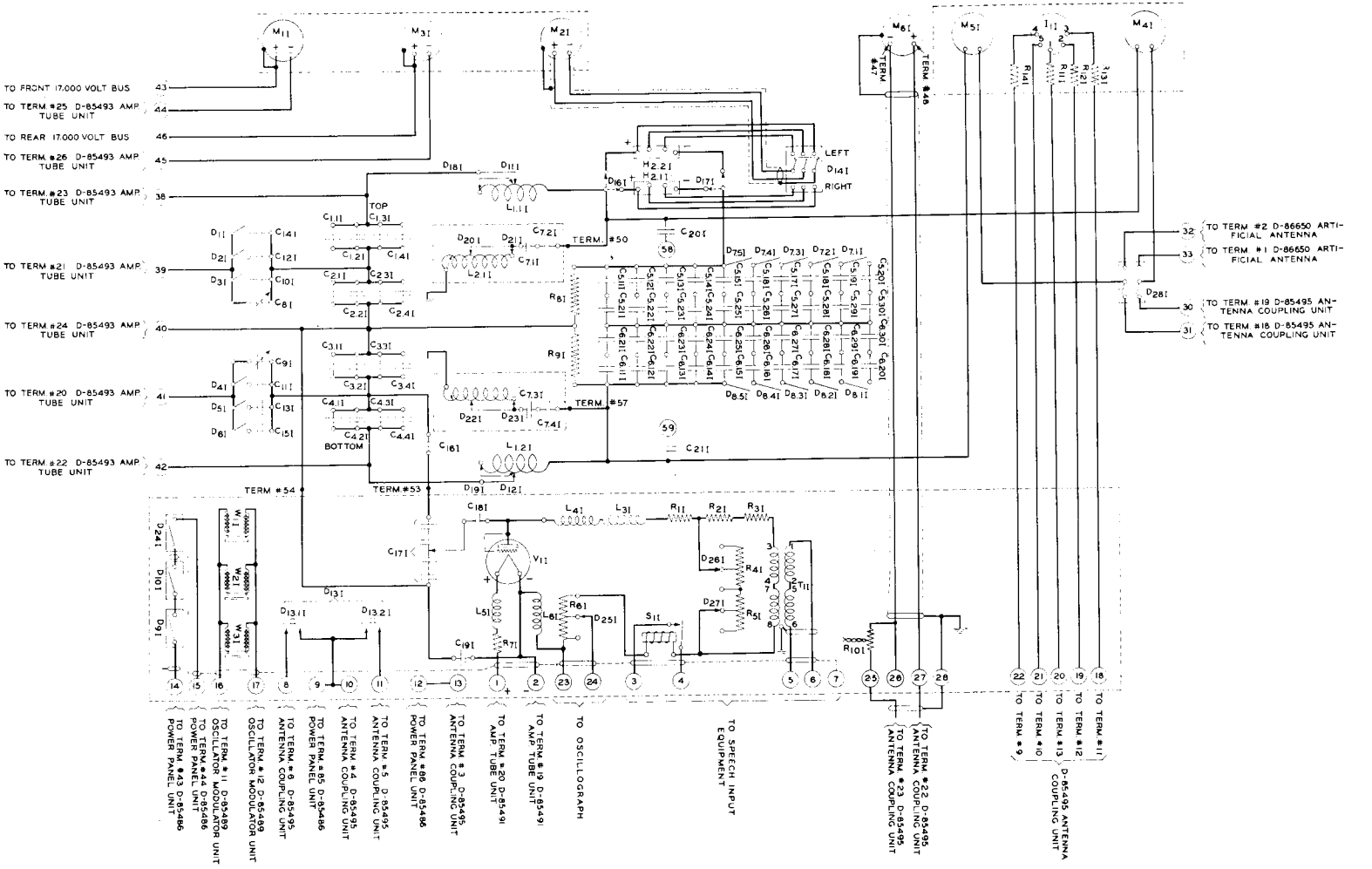
No. D-85493 Third Power Amplifier Tube Unit—Rear View



No. D-85493 Third Power Amplifier Tube Unit—Left Side View



No. D-85493 Third Power Amplifier Tube Unit—Right Side View



Schematic of No. D-85494 Third Power Amplifier Tuning Unit

No. D-85494 Third Power Amplifier Tuning Unit.

The tuned output circuit includes the following: the condensers C1I, C2I, C3I and C4I, the coil L1I (divided into two parts L1.1I and L1.2I) and the transmission line coupling condensers C5I and C6I. By reference to the circuit diagram of the Third Power Amplifier Tuning Unit shown on pages 82 and 180 a comprehensive idea of the banks of condensers that are grouped together in this tuned circuit can be obtained.

The output circuit is approximately tuned to the carrier frequency by adjusting the position of the clips D18I and D19I on the coil L1I. The end turns of L1I are short circuited by the straps D11I and D12I. A continuously variable adjustment of the inductance of L1I is obtained by means of a closed ring located at the center of the coil. The current through the coupling condensers is measured by means of H2.1I when M2I is connected to it by means of D14I, D16I and D17I. The value of the capacitance of C5I and C6I and the resistance of the transmission line shunting them determines the load impedance of the tuned circuit.

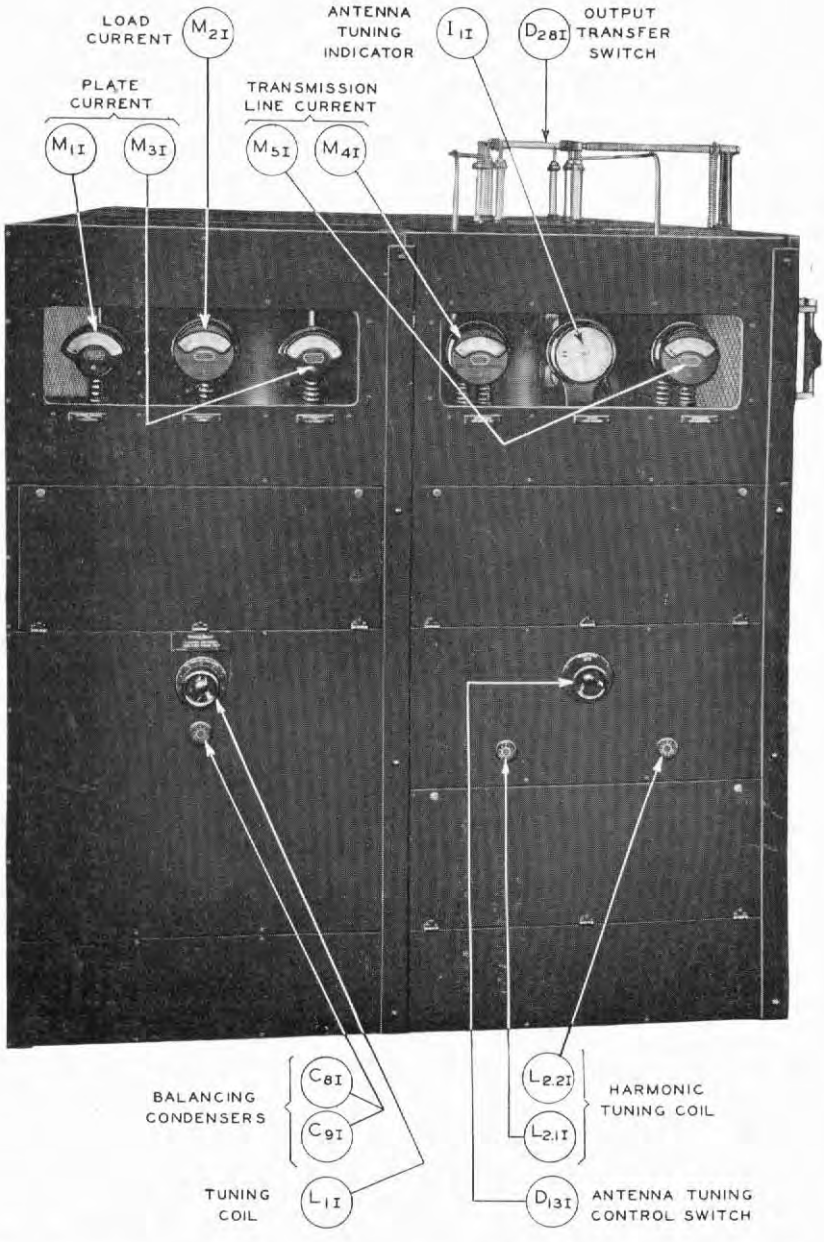
When less than six tubes are used in the amplifier more condensers are added to the bank of coupling condensers by the means of switches, such as D7I and D8I. The value of the capacitance added is sufficient to increase the impedance of the tuned circuit to the value required by the fewer number of tubes.

The Third Power Amplifier Circuit is neutralized by means of C8I, C10I, C12I, C14I, C9I, C11I, C13I, C15I. The capacities of C8I and C9I are varied simultaneously by means of a common control shaft. The fixed condensers are added by the links D1I, D2I, D3I and D4I, D5I, D6I, (See pages 82 and 180). When less than six tubes are used in the amplifier the capacitance of the neutralizing condensers is reduced by disconnecting fixed condensers from the circuit.

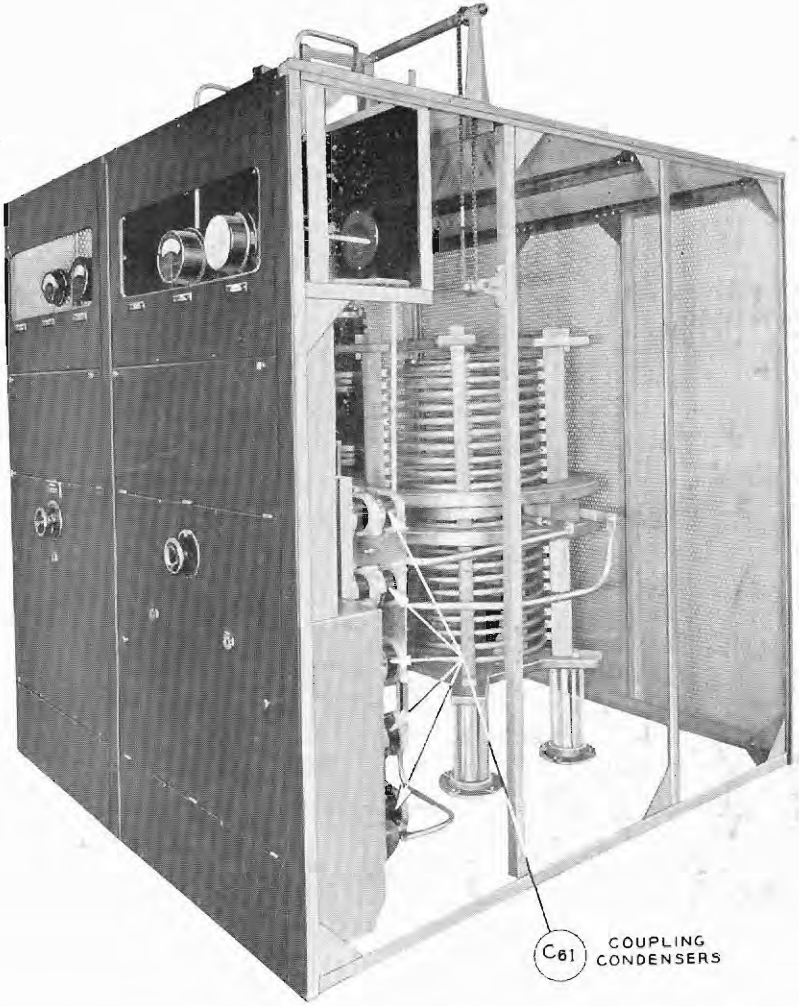
When neutralizing adjustments are made in the Third Power Amplifier Circuit the low reading thermocouple H2.2I is connected in series with the coupling circuit by means of the links D16I and D17I. At the same time M2I is connected to H2.2I by means of D14I. Before this adjustment is made D3H and D4H in the plate circuit leads to the vacuum tubes are opened. The output circuit of the Third Power Amplifier Unit may be connected either to the transmission line and Antenna Coupling Unit or to the Artificial Antenna Unit by means of the transfer switch D28I. In either case the transmission line current is measured by M4I and M5I.

R8I and R9I connected across the coupling condensers are provided for the purpose of draining any static charge that may accumulate on these condensers.

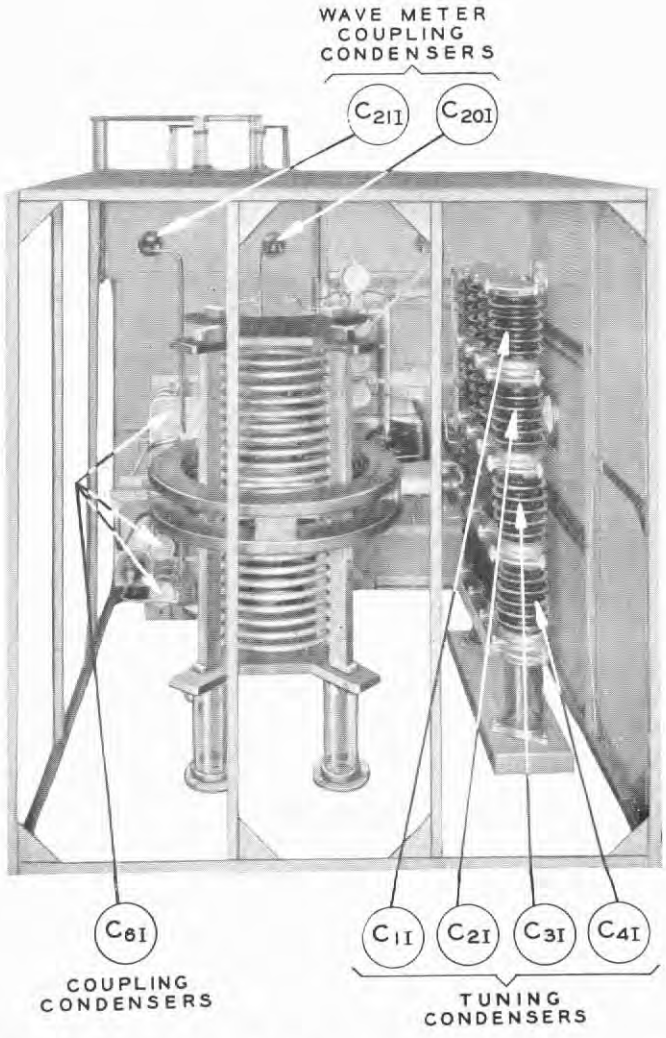
The series circuits consisting of C7.2I, C7.1I, L2.1I and C7.4I, C7.3I, L2.2I connected across the coupling condensers are tuned individually to series resonance at the second harmonic frequency. These circuits then act as low impedance shunts for the second harmonic currents from the output of the amplifier. The harmonic shunt circuits are tuned separately with the aid of a wave meter connected temporarily between a ground connection and one of the wave meter coupling condensers C20I or C21I.



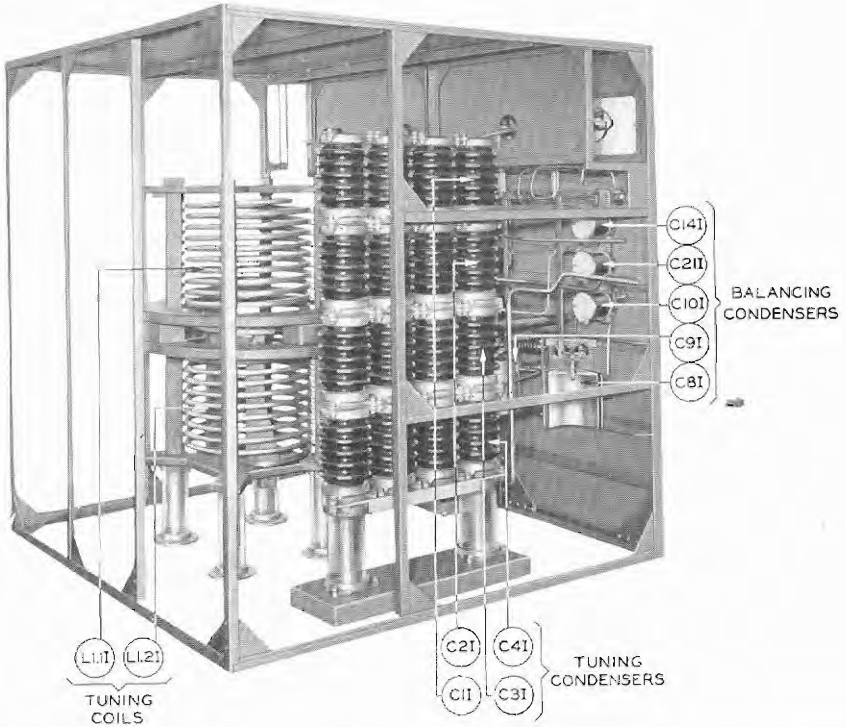
No. D-85494 Third Power Amplifier Tuning Unit—Front View



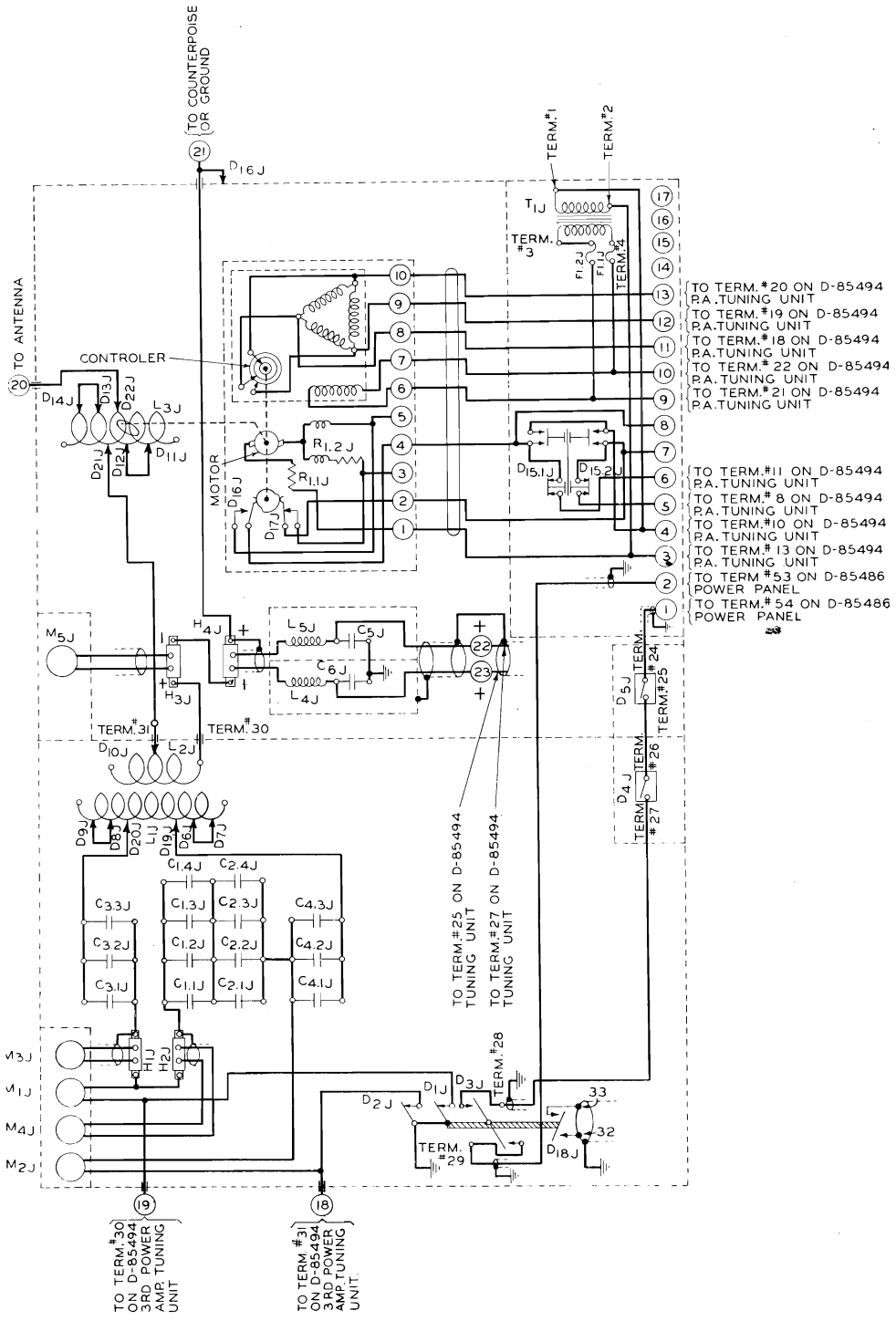
No. D-85494 Third Power Amplifier Tuning Unit—Right Side View—Right Side Removed



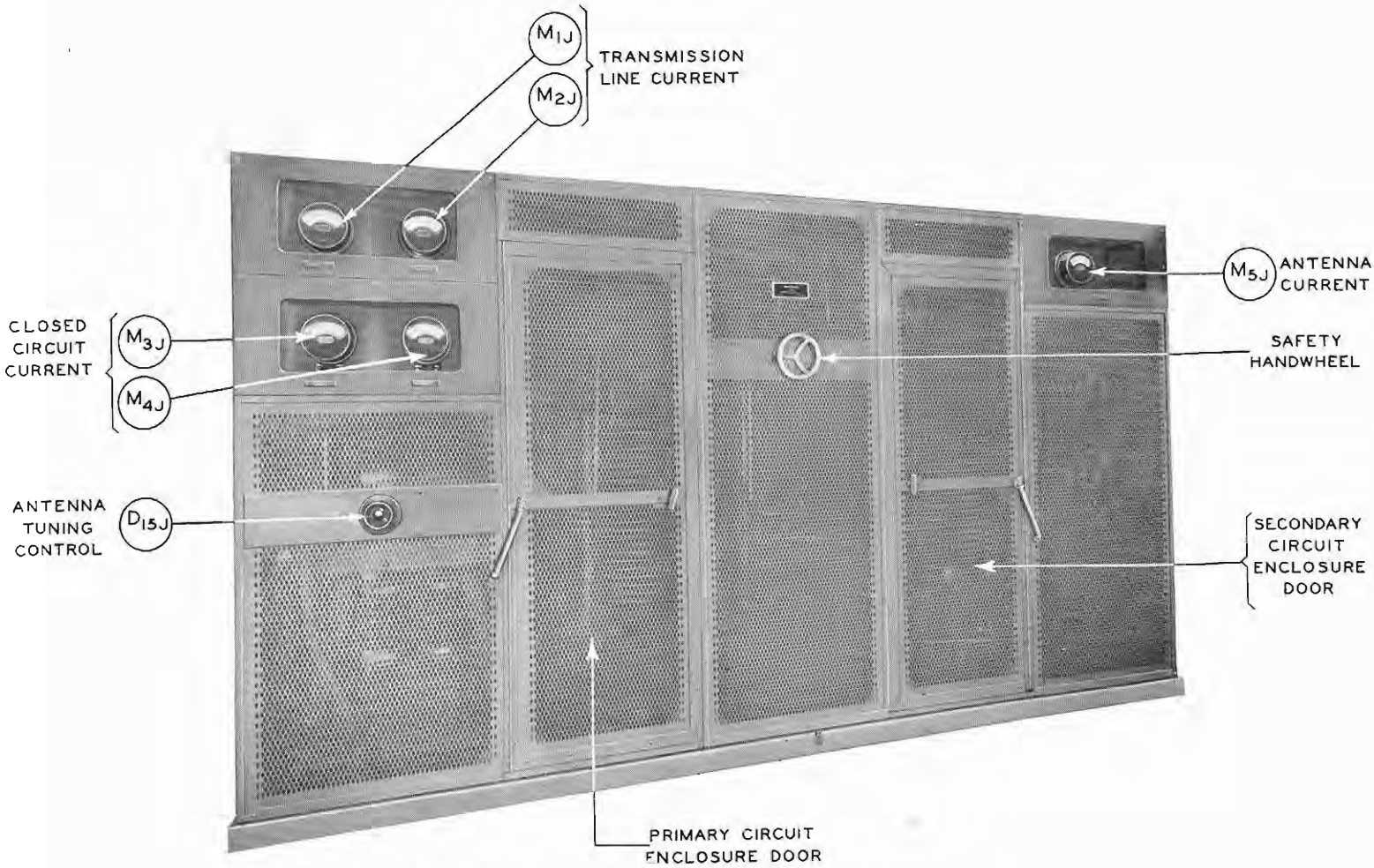
No. D-85494 Third Power Amplifier Tuning Unit—Rear View—Right and Rear Sides Removed



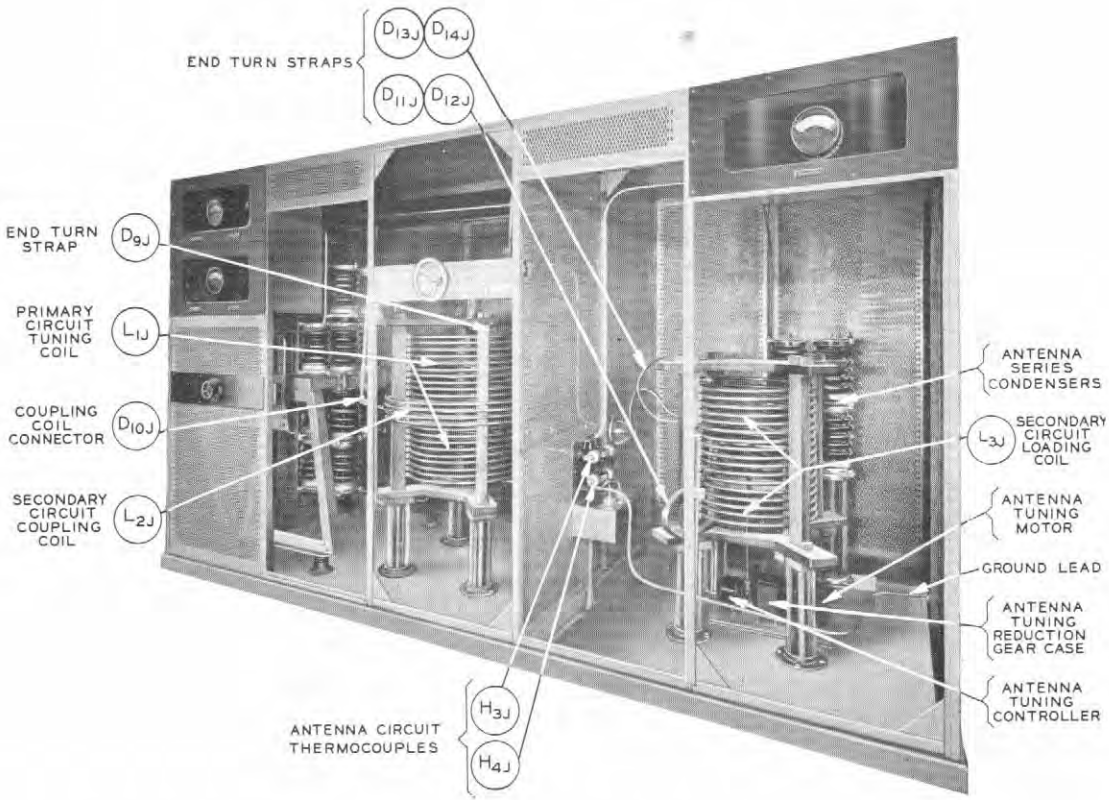
No. D-85494 Third Power Amplifier Tuning Unit—Left Side View—Sides Removed



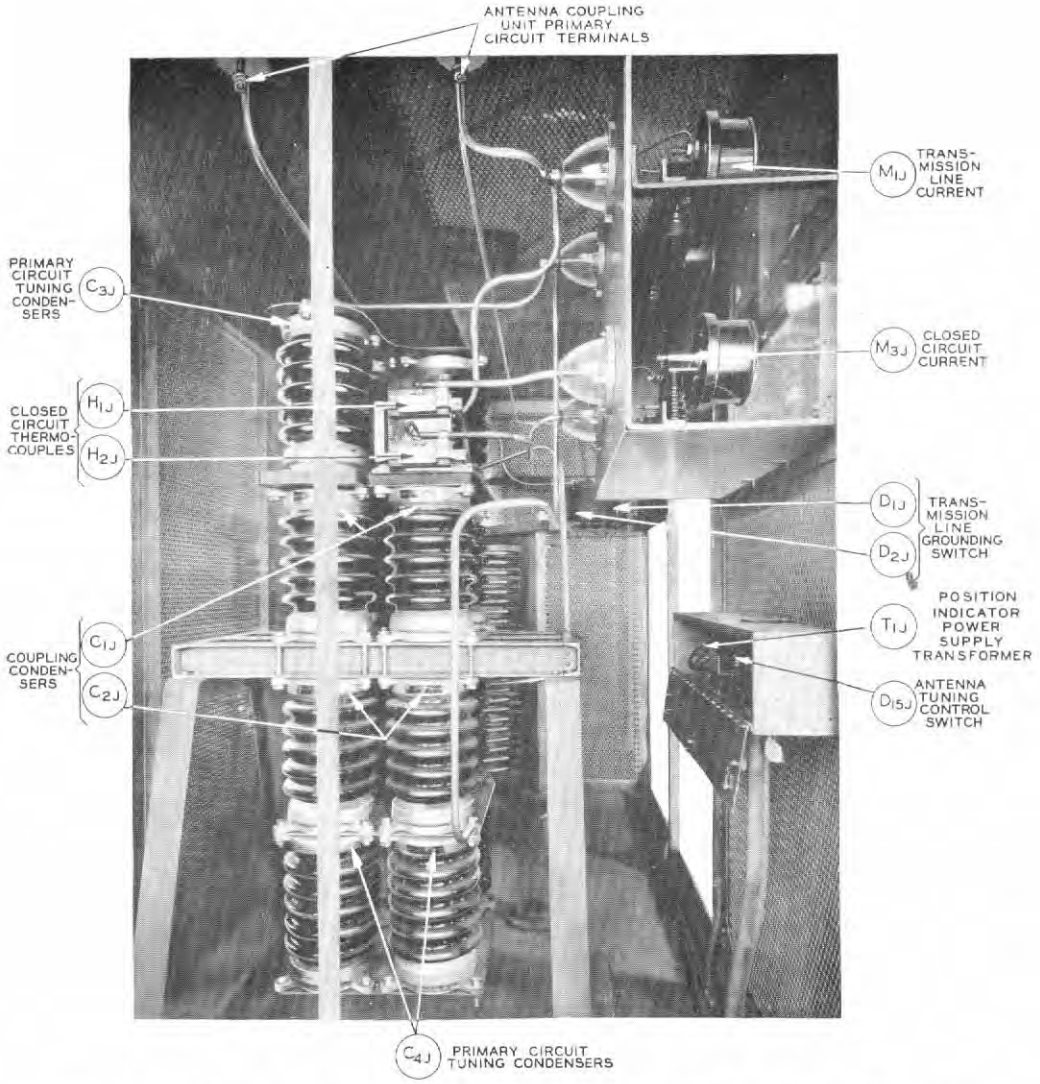
Schematic of No. D-85495 Antenna Coupling Unit



No. D-85495 Antenna Coupling Unit—Front View



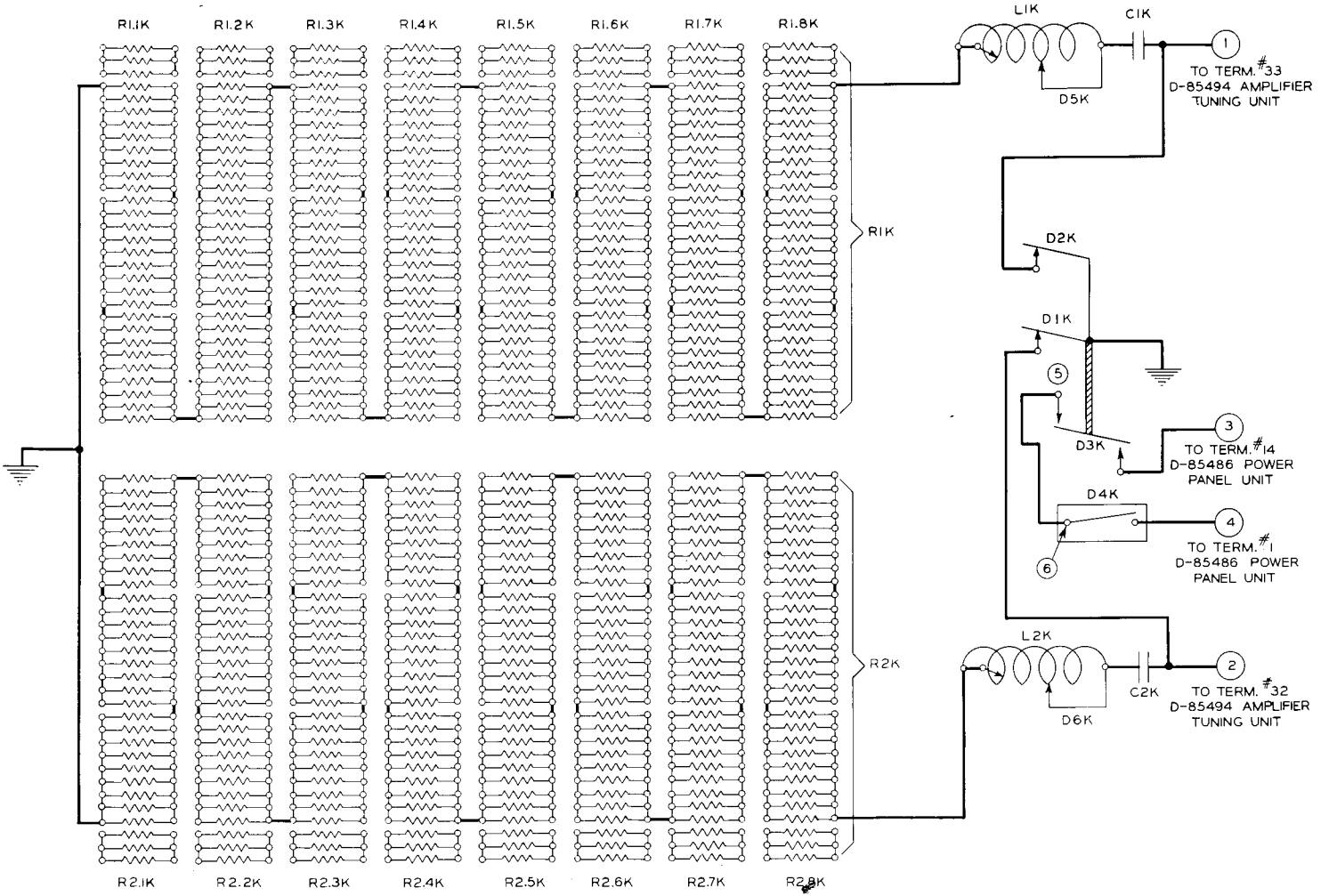
No. D-85495 Antenna Coupling Unit—Front View—Doors and Sides Removed



No. D-85495 Antenna Coupling Unit—Left End View—Sides Removed

No. D-85495 Antenna Coupling Unit.

The Antenna Coupling Unit contains a double tuned coupling circuit connected on one side to the transmission line and the other side to the antenna. The primary circuit of this unit consists of the following elements connected in series, coil L1J and the condensers C1J, C2J, C3J and C4J. The group of condensers C1J and C2J terminate the transmission line and couple it to the primary of the antenna coupling circuit. M1J and M2J are in series with the transmission line and measure the line current. Thermocouple H2J in series with the coupling condensers, together with meter M4J measures the current in the coupling condensers. Thermocouple H1J in series with coil L1J together with meter M3J measures the current in the primary of the antenna coupling circuit.



Schematic of No. D-86650 Artificial Antenna Unit

The primary circuit is tuned by varying the number of turns of L1J until a particular ratio between these currents is obtained. D6J, D7J, D8J and D9J are used to short circuit the unused end turns of L1J. The antenna circuit is coupled to the primary circuit by means of L2J, and it is adjusted to resonate to a particular frequency by adjusting L3J.

Large variations in the adjustment of inductance of L3J are obtained by means of clips D21J and D22J. Clips D11J, D12J, D13J and D14J are used to short-circuit the unused end turns of L3J. Adjustment of the inductance is made by rotating a closed ring in the field of L3J. The antenna current is measured by means of thermocouples H3J and H4J connected to meters M5J and M6I respectively. M6I connected to H4J is located at the right end of the Transmitter Unit Assembly. The choke coils L4J and L5J in the circuit between H4J and M6I together with C5J and C6J across the circuit to a ground connection act as a filter to drain radio frequency current from the circuit leading to M6I. Resistance R10I in series with the circuit of the meter M6I is provided to compensate for the variations in the resistance of different circuit lengths.

The ground lead is connected to the ground system by link D16J. If a counterpoise is used this link is removed.

Switches D1J and D2J are operated by the handwheel at the entrance to the Antenna Coupling Unit. When the handwheel is turned to the protection position these switches ground and short-circuit the input terminals of the antenna coupling unit.

No. D-86650 Artificial Antenna Unit.

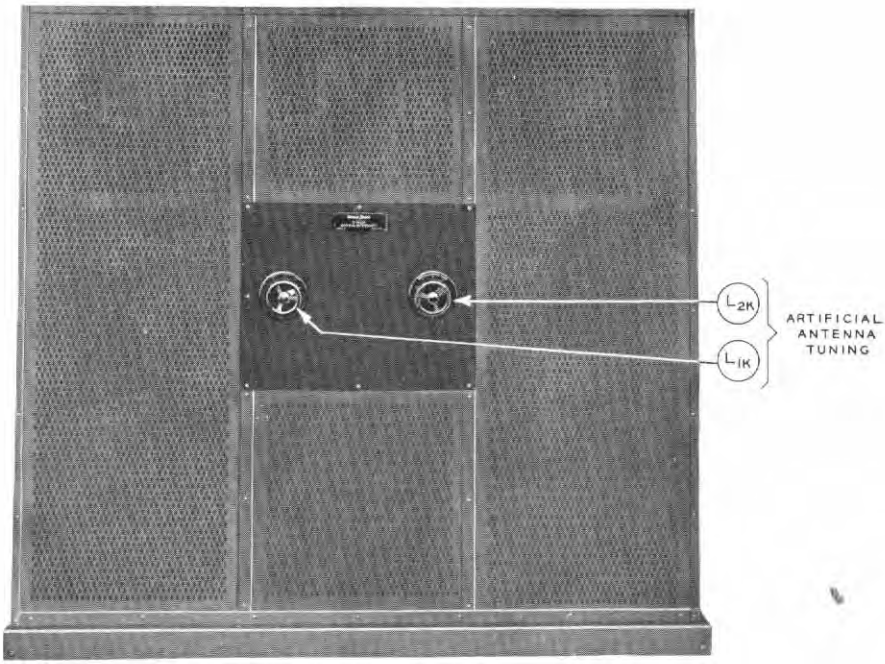
The Artificial Antenna Unit is used as a load when it is desired to operate the transmitter without radiating. R1K and R2K are adjusted to predetermined values and L1K and L2K are adjusted to obtain a particular value of the closed circuit current and transmission line current in the Third Power Amplifier Tuning Unit.

The reactance of the circuit is balanced by coils L1K and L2K. D5K and D6K are used to short-circuit the unused end turns of L1K and L2K.

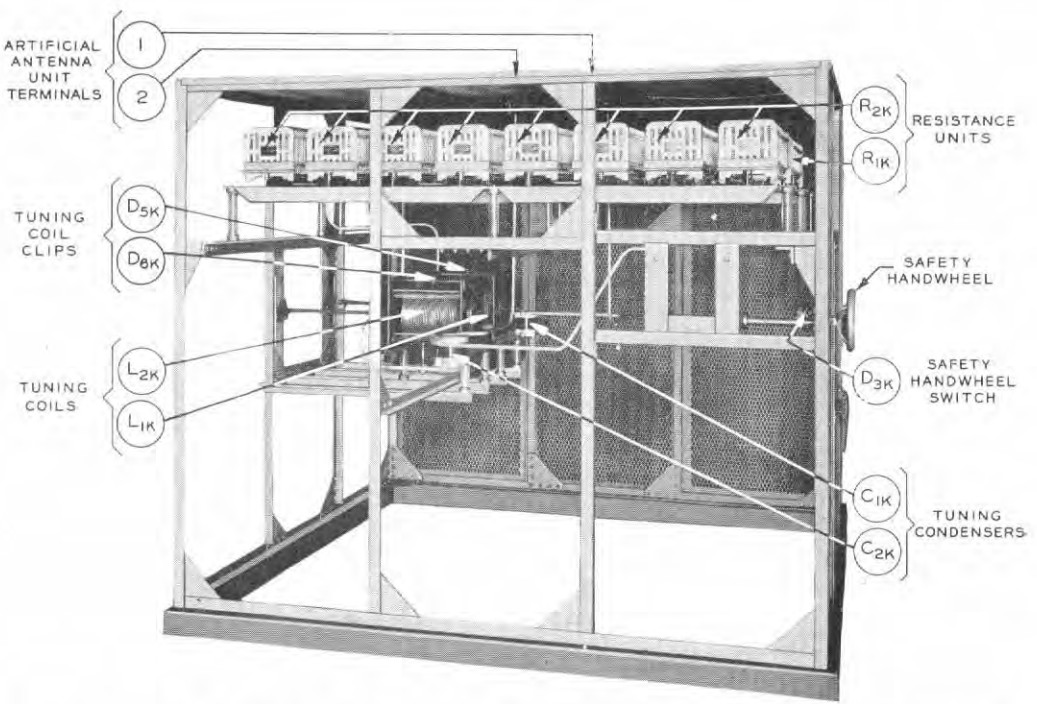
D1K and D2K are operated by the handwheel at the entrance to the Artificial Antenna Unit. When the handwheel is turned to the protection position the input terminals of the unit are connected to ground and short circuited.

In order that the operator may check the quality of the program signal at the output of the transmitter, a monitoring rectifier, located in the Third Power Amplifier Tuning Unit, is connected to the tuned circuit in that unit.

The taps on condenser C17I provide a means of varying the amplitude of the radio frequency voltage applied to the rectifier. Connections D26I and D27I on resistances R4I and R5I are provided to vary the audio frequency output of the rectifier. C18I is an audio frequency stopping condenser while C19I is a radio frequency by-passing condenser. L3I, L4I and L6I are radio frequency chokes. S1I is a relay operated by the DC component of the rectified current and



No. D-86650 Artificial Antenna Unit—Front View



No. D-86650 Artificial Antenna Unit—Right Side View—Sides Removed

it is used to close the circuit of a signal lamp in the speech input equipment to indicate that the transmitter is in operation. The output of transformer T1I goes to the speech input equipment where it is fed into a monitoring amplifier and loud speaker. Tapped resistance R6I is provided so that an oscillograph may be connected to the rectifier circuit should it be desired to observe the wave form of the output or determine the percentage of moduiation of the carrier.

WATER COOLING SYSTEM

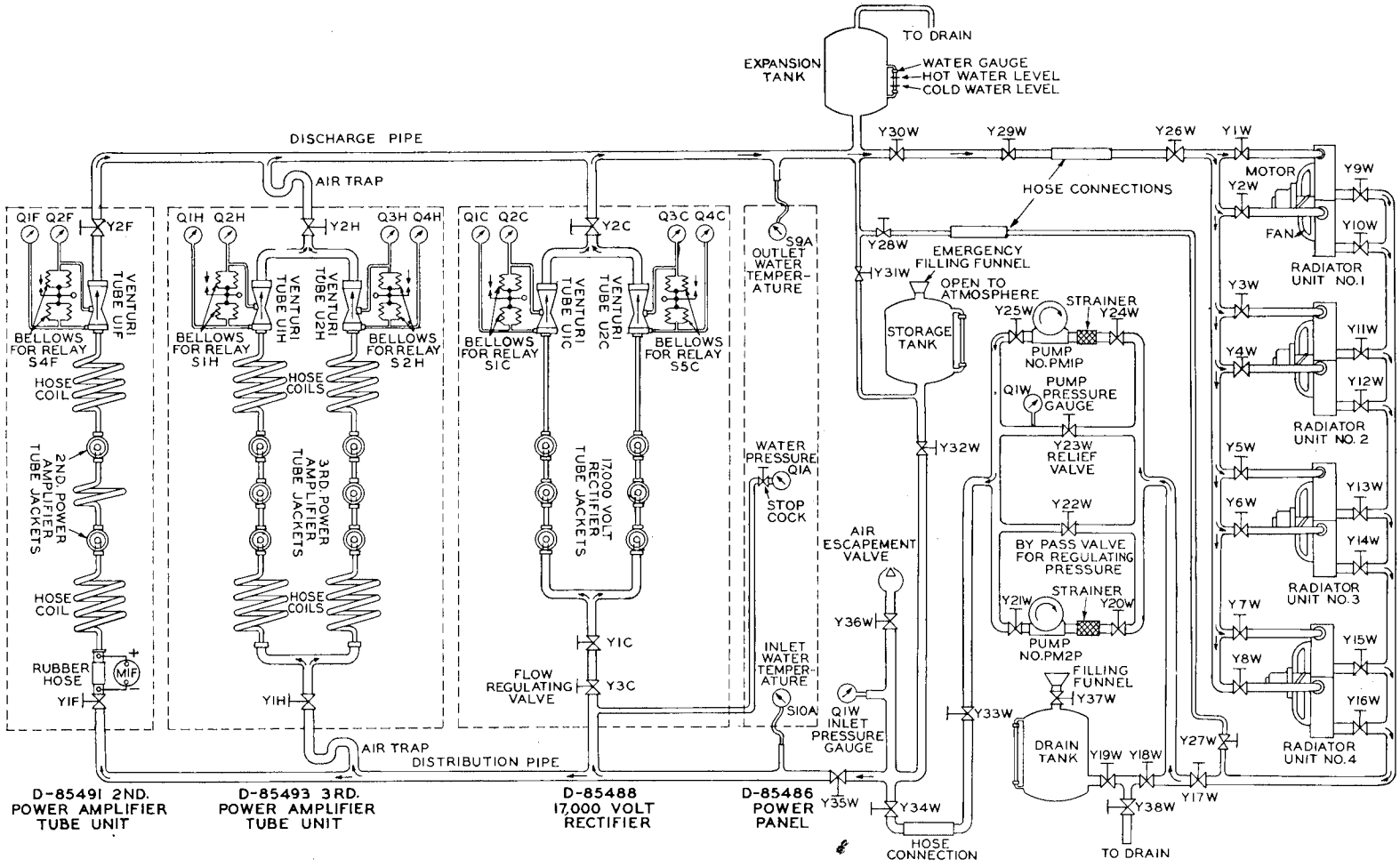
The Water Cooling System shown on pages 96 and 188 consists of apparatus located in the Transmitter and Power Unit Assemblies as well as in the pump and radiator rooms of the station building. The functions of that portion of the apparatus in the transmitter are to remove the heat dissipated from the plates of the power vacuum tubes and to protect these tubes from an interruption in the flow of cooling water. The apparatus in the radiator and pump rooms functions to remove the heat from the cooling water and to circulate the water through the vacuum tube jackets in the transmitter.

The water is circulated by means of a motor driven pump. The cooling water passes from the pump through distributing pipes to the 17,000-volt rectifier tube jackets, the Third Power Amplifier Tube Jackets and the Second Power Amplifier Tube Jackets. In the 17,000-volt rectifier and in the Third Power Amplifier, the inlet pipes branch and water passes through two sets of three vacuum tube jackets connected in series. The cooling water after passing through the tube jackets flows through a Venturi tube connected in the outlet pipe from each group of tube jackets. From the outlets of the Venturi tubes, the pipes from the 17,000-Volt Rectifier Unit and the Second and Third Power Amplifier Tube Units join and the water flows through a common discharge pipe to the intake of four radiators equipped with motor driven fans. The discharge outlets of the radiators are connected to the suction port of the pump through a strainer.

The Venturi tube in the outlet from each group of vacuum tube jackets has pressure tubes connected from its inlet and throat to the upper and lower bellows of a No. 226-A Relay. The Venturi tubes, U1C and U2C in the 17,000-Volt Rectifier Unit are connected to the No. 226-A relays S1C and S5C respectively. The pressures on the bellows of these relays are indicated by the pressure gauges Q1C, Q2C, Q3C and Q4C.

The Venturi tubes U1H and U2H in the Third Power Amplifier Tube Unit are connected similarly to the No. 226-A relays S1H and S2H. The pressures on the bellows of these relays are indicated by gauges Q1H, Q2H, Q3H and Q4H. The Venturi tube U1F in the water cooling circuit of the 2nd Power Amplifier Tube Unit is connected similarly to the bellows of S4F. The pressures on the bellows of this relay are indicated by gauges Q1F and Q2F.

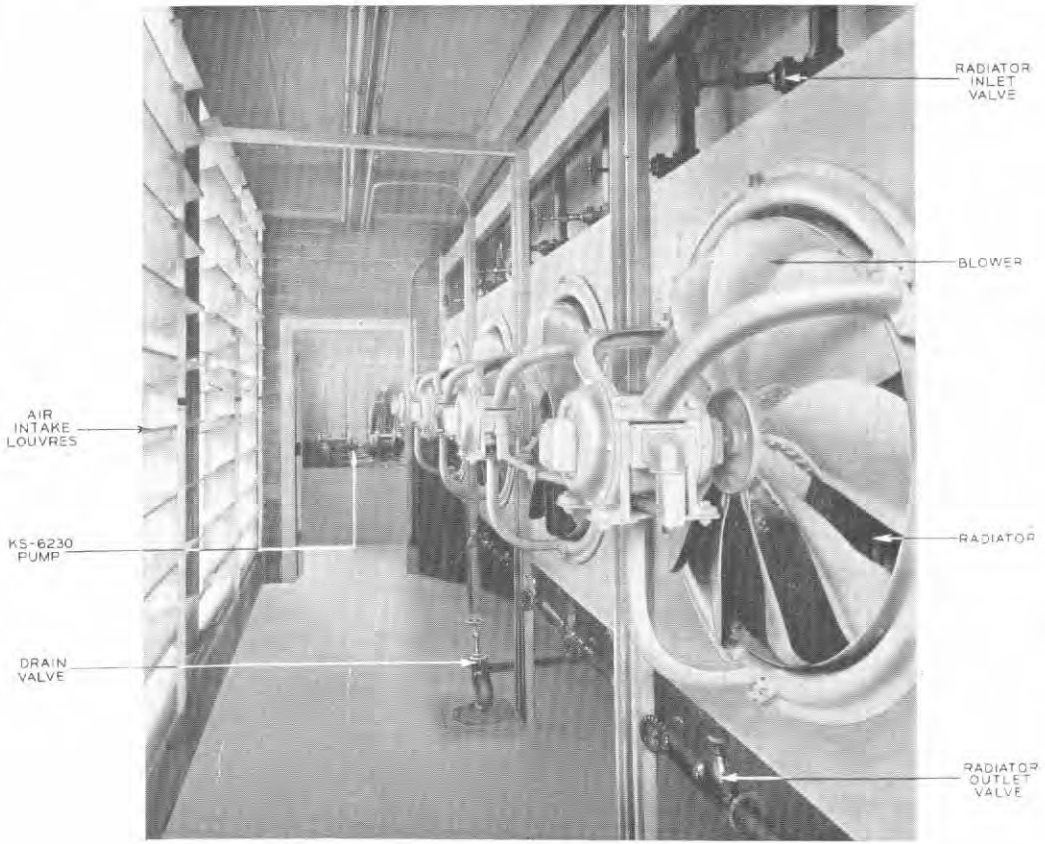
Insulation between the tube jackets in the Second and Third Amplifier Tube Unit and the rest of the Water Cooling System is provided by the columns of water in the hose coils in these units and in order that a check may be kept



Schematic of Water Cooling System

on the insulation resistance of the water, meter M1F is provided to indicate the leakage of current through one hose coil in the Second Power Amplifier Tube Unit. This meter is connected to metallic nipples separated by a short piece of hose near the grounded end so that the leakage current is shunted through the meter.

The temperature of the cooling water in the distribution pipe is indicated by the thermometer dial S10A located on the power panel. The temperature of the cooling water discharged from the tube jackets is indicated by the thermometer dial S9A. The bulb of this thermometer is placed in the discharge pipe leading to the radiators and it measures the temperature of the mixed water from the rectifier and power amplifier units. The pressure of the cooling water in the distribution pipe is measured by the pressure gauge Q1A located on the Power Panel. The cooling radiators are connected between the discharge pipe from the Transmitter Units and the suction port of the pump. Valves are placed in the inlet and outlet from each branch radiator circuit. If it becomes necessary to repair a radiator or remove one from the Cooling System the valves at the inlets and outlets of the branch including the faulty radiator are closed.



No. 7 Venturifin Unit and No. KS-6230 Pump

Valves are placed in the suction and discharge ports of each of the pumps. The valves on the suction port and discharge port of the pump being used are open and the corresponding valves in the ports to the pump not in use are closed. Two by-pass circuits around the pumps are provided for the purpose of protection against excessive pressure. The first by-pass circuit has a relief valve in it which is adjusted to by-pass water around the pump if the pressure exceeds 85 pounds. In the second by-pass circuit is a gate valve which may be left partly open when necessary in order to reduce the water pressure. The water pressure required to provide normal water flow will vary in different installations. To prevent the transmission of mechanical vibration or noise from the pump and radiator fans to the transmitter units, three sections of rubber hose are placed in the piping; one adjacent to the discharge outlet of the pump, one in the pipe discharging into the radiators and adjacent thereto and one in the by-pass filling pipe which connects the discharge pipe to the outlet of the radiators. This by-pass pipe is normally closed by a control valve and is used only for initial filling or complete refilling of the water system. By making use of this by-pass filling line all entrapped air in the radiators is forced out through the expansion tank because the radiators are filled from the bottom.

Adjustment of Apparatus and Circuits

The following information on the adjustment of the apparatus and circuits of the No. 7-A Radio Transmitter assumes that the units of the transmitter have been installed correctly and that all the interconnecting circuits between them are complete. Although detailed installation information is not given in this instruction bulletin, there is contained in it sufficient information to enable checking the wiring of the transmitter and correcting any faults.

Adjustment of Apparatus

Fuses.

Each of the fuse mountings is marked with the rating of the fuse which it should hold. The types and sizes of the different fuses will be found listed on page 139. Each fuse should be tested for continuity before placing in the fuse mounting.

Vacuum Tubes.

Vacuum tubes should be inserted in the tube sockets corresponding to the information given on page 142. Both of the No. 212-D Vacuum Tubes used in the No. D-85490 first Power Amplifier Tube Unit should have the same class number (1, 2, 3 or 4) or consecutive ones etched on the glass near the base.

Lamps.

Lamps should be placed in the sockets located on the front of the No. D-85489 Oscillator Modulator Unit and in the Antenna Grounding Switch Control Box. Information on the type of lamps to be used may be obtained from the list of resistances on page 140.

Spark Gaps and Protectors.

The spark gap terminals should be kept clean and bright and the gap distances adjusted as specified in Table I. The copper blocks in the No. 60-B

Table I—Spark Gaps and Protectors

Location of Safety Gap	*Designation*	*Gap Distance Inches*
No. D-85487 Rectifier Unit—	G1B	0.075
Unit B	G2B	0.075
	G3B	0.075
No. D-85491, Second Power	P1F	0.010
Amplifier Tube Unit—Unit F		Protector Mica No. 10
No. D-85493, Third Power	P1H	0.010
Amplifier Tube Unit—Unit H		Protector Mica No. 10
Transformer and Filter Room		
Interphase Reactor L1P	G12P	0.375
Filter Coil L4P	G1P	0.141
Filter Coil L3P	G2P	0.141
Plate Transformer T1P	G3P and G8P	0.55
Plate Transformer T2P	G4P and G9P	0.55
Plate Transformer T3P	G5P and G10P	0.55
Plate Transformer T4P	G6P and G11P	0.55
Plate Voltage Voltmeter	G7P	0.010
		Protector Mica No. 10

Protectors should be smooth and clean and the mica spacer should be free from burnt spots.

Relays

The current setting of the type PQ relays is made by varying the position of the plunger in the coil. The adjustment nut on the bottom of the calibration tube is provided for this purpose. The adjustment is made by placing the line on the plunger opposite the desired operating point on the calibration.

Time settings of the type PQ time delay relays are obtained by means of the needle valve located at the top of the air bellows. A knurled locknut is provided for locking the needle valve after the adjustment is made. Adjust the overload relays to operate at the values of current indicated in Table II and make the time delays as indicated in this table.

The delay interval of the time delay relays starts with the upward movement of the plunger and ends with the closing or the opening of the relay contacts. The adjustment of Starting Relay S7A and the settings of all overload relays should be made before adjusting the radio frequency circuits. 17,000-Volt Delay Relay S8A should be adjusted afterwards.

Adjust the contacts on S9A "OUTLET WATER TEMPERATURE" to minimum of 40 degrees and maximum of 165 degrees and on S10A "INLET WATER TEMPERATURE" to minimum of 40 degrees and maximum of 150 degrees.

TABLE II—OVERLOAD RELAY TRIPPING CURRENT AND TIME DELAY ADJUSTMENTS

Designation	*Tripping Current, Amperes*	*Time Delay, Seconds*
S7A	———	20
S8A	———	20
S4B	1.5 DC	None
S5B	0.7 DC	None
S6B	0.7 DC	None
S7B	0.7 DC	None
S2C	15.0 DC	None
S3C	5.0 AC	4
S4C	5.0 AC	4
S1F	1.5 DC	None
S2F	1.5 DC	None
S3H	10.0 DC	None
S4H	10.0 DC	None

The adjustment arms of S13A should be set at the 120 per cent rating mark. After the temperature relay has tripped it may be reset by hand after having had a few seconds to cool.

Current Transformers

Inspect current transformers T2A and T3A and make sure that the shunts placed on them when the apparatus was shipped have been removed.

Quartz Oscillators

Quartz Oscillators of the desired frequency should be placed in each of the two crystal heater units. To do this it will be necessary to remove the thermal elements from the heater units but before this can be done the thermometers must be withdrawn. The thermometers should be handled carefully during the process of removing and replacing them.

The No. D-87781 Quartz Oscillator as received, contains a piezo-electric quartz crystal which is padded with lens paper in order to facilitate shipping. This padding must be carefully removed in accordance with the following procedure before attempting to place the crystal oscillator into operation.

1. Remove the three outer screws clamping the crystal housing to the lower electrode. In doing this care shall be taken not to separate the housing from the lower electrode as this will likely tear the foil connecting the upper plate or electrode and the center terminal of the cup.

2. Carefully invert the oscillator, taking care to keep the housing and lower electrode intact. Then remove the metal base or electrode. Remove the padding of lens paper between the crystal and the lower electrode. Carefully lift out the crystal by its edges. DO NOT TOUCH SURFACES OF THE CRYSTAL.

3. Clean the crystal, crystal compartment and electrodes with the lens paper used as padding.

4. Replace the crystal and reassemble.

The Quartz Oscillator is now ready to be placed into operation. Care should be taken not to shake it unduly as there is considerable space for movement of the electrodes, and careless handling without the lens paper insertion in place may seriously injure the crystal.

Water-Cooling System, Hot and Cold Water Levels

The Water Cooling System should be filled with distilled water by the following procedure. (Refer to schematic, pages 96 and 188).

a. Close valves Y38W, Y17W, Y27W, Y28W, Y31W, Y35W, Y20W, Y21W and Y22W. Open valves Y18W, Y19W, Y37W, Y24W, Y25W, Y33W, Y34W, Y32W and Y36W.

b. Fill the drain tank completely through the filling funnel.

c. Open switches D3P, D4P, D10P, D11P, D12P and D13P and throw switch D9P so that pump PM1P is connected in circuit. (See schematic pages 8 and 147).

d. Open disconnect switches D2A and D1B and turn snap switch D7D to the OFF position. Close the main power supply switch and switches D2D and D1A. Close the doors and windows of the transmitter unit assembly, the power unit assembly, the artificial antenna unit, the antenna coupling unit and close the door at the entrance of the Transformer and Filter Room. Press the "OFF" button of "RECTIFIER CONTROL" switch D4B. (See schematics, pages 12 and 13, and 148 and 149).

e. Start pump PM1P by pressing the "ON" button of the "MASTER CONTROL" switch D3A.

f. When the water which was in the drain tank has been pumped into the storage tank, close valve Y32W and shut off the pump by pressing the "OFF" button of the "MASTER CONTROL" switch D3A.

g. Refill the drain tank. Open all valves except Y17W, Y31W, Y38W, Y21W and Y20W.

h. Fill the water circulating system by starting the pump as described in paragraph e; this will draw the water out of the drain tank, force it up through the pipe and tube sockets, through valves Y28W and Y27W to the bottom of the radiators, then up through the radiators pushing the enclosed air ahead of it, finally filling the expansion tank. When water appears in the glass gauge of the expansion tank, valve Y18W should be closed and the pump stopped. The water should be allowed to settle in the system for a few minutes during which air will bubble out through the expansion tank. The level of the water in the expansion tank will drop as the air is released. This level may again be brought up either by starting the pump and opening valve Y18W or by opening valve Y31W allowing the water to run into the system from the storage tank. Valve Y17W should then be opened and valve Y28W should be closed. The pump should again be started for a few minutes and then stopped to allow the further release of air. If the level of the water in the expansion tank again decreases, it should be brought up by opening valve Y31W. The pump should be started and stopped several times until the level of the water in the expansion tank remains constant when the pump is not running, showing that all of the air in the system has been driven out.

i. In filling the Water Cooling System, sufficient distilled water should be used to bring the water level up to the top of the tube jackets and this level should be marked on the expansion tank water gauge. After the transmitter has been adjusted and tuned as described under Adjustment of Circuits and Tuning Procedure, the transmitter should be run until the outlet water temperature rises to 150 degrees F. (with one or more fans not operating if necessary). The water should then be allowed to drain back into the drain tank by opening valves Y18W and Y19W until the level of the hot water is brought down to the mark which was made on the gauge of the expansion tank when the water was cold.

This is the hot water level mark. After the transmitter has been shut down and the water is cooled to room temperature, another mark should be made on the gauge of the expansion tank at the level to which the water has fallen on account of cooling. This is the cold water level mark. When the water is cold, its level should always be kept up to but not above the cold water level mark, and in normal operation after the water has become heated, its level will be somewhere between the hot and cold water level marks, depending on its temperature. All water replacements should be made when the water is cold. If this is done, it will not be necessary to shut valves Y1F, Y2F, Y1H, Y2H or Y1C, Y2C, when replacing tubes in the respective units as the static water level will never be higher than the tops of the tube jackets.

It is of utmost importance to keep the strainer clean. It will be found that immediately after the system has been installed and for a considerable period thereafter, frequent cleaning will be required. As the loose material resulting from the new plumbing is eliminated from the system, the necessity of cleaning will become less frequent and can best be determined by operating experience for a particular installation.

Except in extremely hot weather, the system will operate satisfactorily with three radiator units so that ordinarily one of the four units serves as a spare. It is recommended that all radiator units be used as uniformly as practicable to insure that the spare will be in operating condition.

During cold weather care should be taken to maintain all parts of the circulating system well above freezing temperature.

The pumps should be used alternately in order to insure that both are always in operating condition. In renewing the gland packing in the pumps, it is recommended that the following be used:

Metalastic "Gray Label" Packing.
Obtain from:
Metalastic Incorporated
Jersey City, N. J.

If it becomes necessary to change or repair any part of the system so that litharge or other materials may be introduced, it will be desirable to flush the system with clean water. Before flushing, the tube units should be by-passed in order to safeguard the small orifices in the Venturi tubes and the vacuum tube sockets. The by-passing may be accomplished in the following manner. Insert a double male nipple after removing the plug in each elbow in the lower end of the vertical inlet and discharge pipes to each unit. Connect a length of hose with a female hose coupling on each end from the inlet to the discharge pipe. Then close the inlet and outlet valves in each unit. The pump should be employed in flushing and the duration of the flushing will depend on the rate of collection of foreign matter in the strainers. Before starting the pump, open valve Y22W in order to relieve the system of excessive pressure. Then gradually close valve Y22W until a good circulation is obtained without subjecting the by-pass connection to excessive pressure.

Power Circuit.

Connect the primary tap links on transformers T1B, T2B, T3B and T4B to the tap terminal marked "normal". Later this adjustment should be checked with full load for a line voltage of 440 volts, to the point marked "+5%" for a high line voltage and to the point marked "—5%" for a low line voltage.

Place the switches that are on the transformers T1P, T2P and T3P in the left hand position (on the first tap). This position is used while making preliminary adjustments on the transmitter.

Grid Voltage Circuit.

Connect switch D6A to the tap with a number corresponding to the class number of tube V5D, and connect switch D7A to the tap with a number corresponding to the highest class number of tubes V1E or V2E. Connect D8A to the 300-volt tap.

Quartz Oscillator Temperature Control Circuit.

Independent temperature control circuits are provided for the two Quartz Oscillators, one for each of the two heater boxes. Either of these circuits may be adjusted without affecting the adjustment of the other.

The temperature of the quartz oscillator may be adjusted by means of the thermostat knob located at the right of the thermometer for the quartz oscillator whose temperature it is desired to change. Push this knob in until it engages with the thermostat control gear and turn it in the proper direction, as indicated by the designations "HIGH" and "LOW". One complete turn in the "HIGH" direction will raise the temperature about 8 degrees C.

Adjustment of the relays on the temperature control panel is accomplished as follows:

NOTE: Whenever any relay adjustment is to be made the power should be cut off by turning the "HEATER SUPPLY" switch to the "OFF" position, as there is a potential of 110 volts between the relay frame and ground. As this switch controls the heat supply to both Quartz Oscillators it should not be open any longer than necessary for making adjustments.

a. Open the "TEST SWITCH", turn the "HEATER SUPPLY" switch to the "OFF" position, remove the cover of the "HEATER CONT. RELAY" and make the following mechanical adjustments:

b. Turn the biasing spring knurled screw at the bottom of the relay so that the spring does not bear against the armature. Adjust the right-hand contact screw until it just makes contact with the armature. Adjust the left-hand contact screw until the gap between it and the armature is between 0.005 inch and 0.004 inch. The gap distance should be adjusted with the aid of a No. 74-D Gauge.

c. Adjust each of the pole pieces so that the gap between it and the armature is 0.010 inch. This gap distance should be measured with the armature

against the opposite contact and with the contact screw lock nuts tightened. A No. 92-A Gauge should be used to check the adjustment of the pole pieces.

d. Turn the "HEATER SUPPLY" switch to the "ON" position. Turn the "RELAY CURRENT ADJ." dial counter-clockwise as far as it will go. The "RELAY CURRENT" meter should indicate between 0.8 and 1.2 milliampere. Slowly decrease this current by turning the "RELAY CURRENT ADJ." dial until the current is reduced to 0.25 milliampere. If the mechanical adjustment of the relay has been made correctly, the armature will remain in the operated position.

NOTE: The armature is in the operated position when it is against the left contact screw. The lamp in the heater circuit on the front of the panel should show a light when the armature is in the operated position.

e. Turn the biasing spring knurled screw so that the spring bears against the left-hand side of the armature and then increase the pressure of the spring against the armature until it releases.

f. Increase the relay current by turning the "RELAY CURRENT ADJ." dial until the relay operates, then decrease the current until the armature releases and observe at what current value this occurs. The armature should release when the current is reduced from a value sufficient to make the relay operate to a value between 0.25 and 0.35 milliampere.

g. If the armature does not release within these limits change the pressure of the biasing spring, decreasing the pressure if the release occurs before 0.35 milliampere and increasing the pressure if the release occurs when the current is less than 0.25 milliampere.

h. Decrease the relay current to a value less than 0.25 milliampere, then increase the current until the relay operates and observe the value of the current at which this occurs. The relay should operate when the current is increased from a value less than the release value to between 0.4 to 0.5 milliampere.

i. If the relay operates when the current is less than 0.4 milliampere screw out the left-hand contact screw a slight amount (not more than one-half turn) thus increasing the gap between the contact and the armature. If the relay does not operate until the current is more than 0.5 milliampere, screw in the left-hand contact screw a similar small amount. A small change only in the gap should be found necessary to make the relay meet these operating requirements.

j. Determine if the relay still releases at a current value within the limits of 0.25 and 0.35 milliampere. If it no longer meets these requirements, change the pressure of the biasing spring, as described in paragraph g, until the relay releases when the current is within these limits.

k. Adjust the dial marked "RELAY CURRENT ADJ." so that maximum relay current is obtained. Throw the "TEST SWITCH" to the "TEST POSITION", and at the same time observe the operation of the relay. Throwing the switch to the "TEST POSITION" should decrease the current to a value at which the armature releases. Open the "TEST SWITCH"; the current should increase to its previous value closing the relay.

Designation	*Location*	*500*	*550*	*600*
D3D (Oscillator Plate Tap)	Under Shield between Crystal Heater Boxes	1	1	1
D4D (Amplifier Input Tap)	Under Shield between Crystal Heater Boxes	3	3	3
Radio Frequency Amplifier Tuning	On Front Panel of Oscillator Modulator Unit	82	60	25
Modulating Amplifier Tuning	On Front Panel of Oscillator Modulator Unit	81	65	70
Modulating Amplifier Balancing Capacitance	On Front Panel of Oscillator Modulator Unit	80	80	70
Radio Frequency Amplifier Input	On Front Panel of Oscillator Modulator Unit	90	90	90
First Power Amplifier Input	On Front Panel of Oscillator Modulator Unit	50	55	40
First Power Amplifier Tuning	On Front Panel of First Power Amplifier Unit	50	55	50
Balancing Capacitance	On Front Panel of First Power Amplifier Unit	30	30	35
Second Power Amplifier Tuning	On Front Panel of Second Power Amplifier Tuning Unit	40	35	60
Balancing Capacitance	On Front Panel of Second Power Amplifier Tuning Unit	80	85	85
Third Power Amplifier Tuning	On Front Panel of Third Power Amplifier Tuning Unit	38	50	31
Balancing Capacitance	On Front Panel of Third Power Amplifier Tuning Unit	65	65	65
L5D (Radio Frequency Tuning Inductance)	In Right Hand Rear Compartment of Oscillator Modulator Unit	52	52	52
L7D (Modulator Amplifier Tuning Inductance)	In Left Hand Rear Compartment of Oscillator Modulator Unit	53	53	43
L6D (Coupling Coil, Top and Bottom)	In Left Hand Rear Compartment of Oscillator Modulator Unit	7	6	6
L6E (Tuning Inductance)	In Shield of First Power Amplifier Unit	28	26	21
L1G (Tuning Inductance)	In Shield of Second Power Amplifier Tuning Unit	29	28	21
C3G and C4G (Fixed Balancing Capacitance)	In Shield of Second Power Amplifier Tuning Unit	0	0	0
L1I (Tuning Inductance)	In Shield of Third Power Amplifier Tuning Unit	25	23	19
C10I, C12I, C14I and C11I, C13I, C15I (Fixed Balancing Capacity)	In Shield of Third Power Amplifier Tuning Unit	A	A	A
C5I (Coupling Capacitance)	In Shield of Third Power Amplifier Tuning Unit	B	B	B
C6I (Coupling Capacitance)	In Shield of Third Power Amplifier Tuning Unit	C	C	C

A=0.00015 Microfarad B=0.003 Microfarad C=0.003 Microfarad

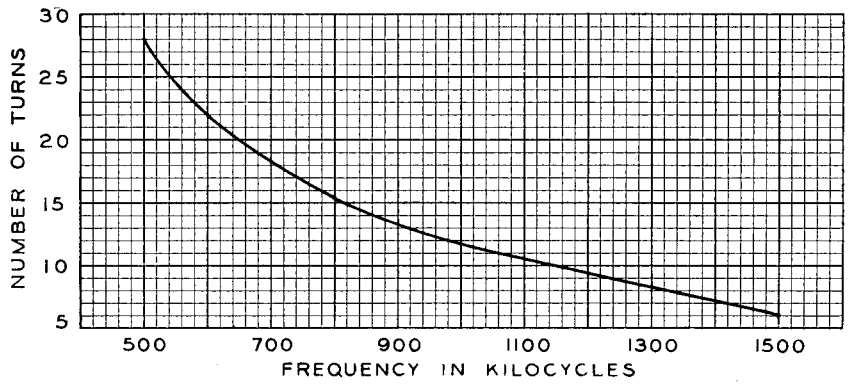
Frequency in Kilocycles																	
650	*700*	*750*	*800*	*850*	*900*	*950*	*1,000*	*1,050*	*1,100*	*1,150*	*1,200*	*1,250*	*1,300*	*1,350*	*1,400*	*1,450*	*1,500*
1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	4
3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
10	4	25	64	46	30	70	50	34	18	68	56	40	31	85	75	60	49
55	56	35	32	28	36	30	24	20	24	22	20	18	16	19	16	14	10
70	66	66	66	66	66	64	66	66	66	66	66	70	70	70	70	70	70
85	80	75	80	70	60	55	50	60	55	50	45	60	50	40	35	30	20
35	30	45	40	35	30	25	40	30	25	55	45	35	50	45	40	35	30
35	43	35	47	47	44	28	60	44	48	69	50	37	63	46	37	26	48
40	56	56	56	56	56	56	56	56	56	56	56	56	58	58	62	62	64
50	54	25	26	41	62	42	10	60	50	33	46	32	19	37	25	50	35
85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
35	21	40	51	35	50	40	10	80	44	45	48	35	30	27	60	40	35
60	60	57	57	50	50	45	40	40	40	33	33	33	33	30	30	30	25
52	37	37	28	28	28	22	22	22	22	17	17	17	17	13	13	13	10
43	34	34	27	27	20	20	20	20	10	10	10	10	10	0	0	0	0
6	6	5	5	5	5	5	4	4	4	3	3	3	2	2	2	2	2
21	18	17	15	14	13	13	11	11	10	9	9	9	8	8	8	8	7
21	18	18	16	14	12	12	12	10	9	9	8	8	8	7	7	6	6
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	17	15	13	13	11	11	11	9	9	11	9	9	9	9	7	7	7
A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

l. Throw the "TEST SWITCH" to the operate position and replace the relay covers.

Radio Frequency Circuit—(Adjustment for an Output of 50 Kw.)

a. Make an approximate setting of the variable elements of the radio frequency circuits of the Transmitter Unit Assembly according to the information given in Table III, pages 106 and 107. *The note on Page 121 should be read in this connection.*

NOTE: Choose settings (given in the table) corresponding to the frequency nearest to that desired. The number of turns indicated for coil L1I is the total number; they should be divided equally between the upper and lower halves of the coil.



Adjustment of Artificial Antenna Tuning Coils L1K and L2K

b. Open switches D2A, D6D, D8D, D2E, D7I and D8I. Close switches D1B, D5G and D6G. Slide D3H and D4H open. Turn D10D to one of the crystals. Disconnect clips D20I, D21I, D22I and D23I. Turn handwheel connected to D28I to the "TEST" position (artificial antenna). Throw the handles of D5D, D3F and D7G down and the handle of D14I to the left. Connect D8G to H2G and D16I and D17I to H2.2I. Connect the turns of L1K and L2K as indicated by the above curve (also page 189). Adjust the resistance of R1K and R2K as indicated by the curve on pages 109 and 189.

NOTE: The value of the resistance should be determined by a wheatstone bridge.

CAUTION: DO NOT USE LESS THAN SIX GRIDS CONNECTED IN PARALLEL IN ANY ONE GROUP.

Connect transformer primary switches D15P, D16P and D17P to tap No. 1.

c. Close safety switches D2D and D1A. Press the "OFF" Button of "RECTIFIER CONTROL" D4B. Close all doors, windows and gates and turn all safety handwheels to the operate position. Turn handles of "FILAMENT GENERATOR" and "GRID GENERATOR" rheostats on the power panel in a clockwise direction as far as possible. Press the "ON" button of "MASTER CONTROL" switch D3A.

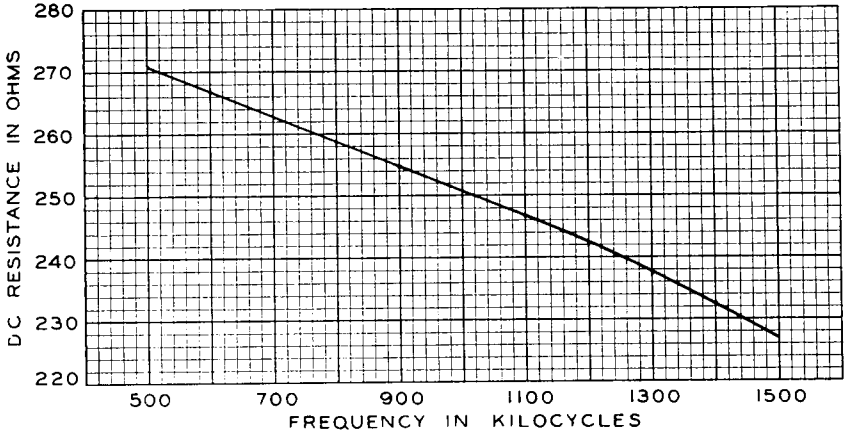
d. Adjust the filament voltage to 20 volts and the grid voltage to 300 volts.

e. Turn the handles of the "RECTIFIER VOLTAGE" and "FILAMENT VOLTAGE" rheostats on the 1,600-volt rectifier panel in a clockwise direction as far as

possible. After the "STARTING RELAY" S7A has operated press the "ON" button of "RECTIFIER CONTROL" D4B and then that of "1600 VOLT RECTIFIER" D2B.

NOTE: Hereafter the operations described in paragraphs c, d and e, are to be performed when necessary without specific instructions to do so. At all times the filament and grid voltages should be maintained at their proper values. After the circuits in the oscillator-modulator and First Power Amplifier Units have been adjusted, the 1,600-volt plate power may be applied directly without turning the "RECTIFIED VOLTAGE" and "FILAMENT VOLTAGE" rheostats to give minimum voltage as described in paragraph e.

f. Tune the radio frequency amplifier by means of the "RADIO FREQUENCY AMPLIFIER TUNING" control to be resonant with the frequency of the oscillator.



Adjustment of Artificial Antenna Resistances R1K and R2K

NOTE: When an amplifier is tuned with plate voltage on, resonance is indicated by a minimum reading on the DC plate current meter.

g. Compare the readings of the "OSCILLATOR GRID CURRENT" the "OSCILLATOR PLATE CURRENT" and the "RADIO FREQ. AMPLIFIER PLATE CURRENT" meters with the current values given in Table IV, Typical Meter Readings. The oscillator grid current in general will be greater at a higher frequency than at a lower one.

NOTE: The end turns of L10D should be short-circuited by the thin link on D3D provided for that purpose, if the "OSCILLATOR GRID" current exceeds three milliamperes. Otherwise place both links on the same tap. Under no circumstances should the grid current be allowed to exceed four milliamperes as the quartz plate will be damaged by excessive current.

h. Stop the transmitter by pressing the "OFF" button of "MASTER CONTROL" switch D3A and close D8D. Turn the "RADIO FREQ. AMPLIFIER INPUT" control to the zero division mark.

NOTE: A spanner wrench is provided with the transmitter for this control and the others of the same type.

i. Start the transmitter. Turn the "MODULATING AMPLIFIER BALANCING CONDENSER" control 10 degrees toward the maximum division mark. Turn the "RADIO FREQ. AMPLIFIER INPUT" control until a quarter scale deflection is obtained on the "MODULATING AMPLIFIER OUTPUT CURRENT" meter. Tune the

TABLE IV—TYPICAL METER READINGS FOR 50-KILOWATT OUTPUT

No. D-85486 POWER PANEL UNIT (UNIT A)

Line Voltage Phase A, M3A	440 ± 5% volts
Line Voltage Phase B, M3A	440 ± 5% volts
Line Voltage Phase C, M3A	440 ± 5% volts
Amplifier Filament Voltage, M1A	20 volts
Amplifier Grid Voltage, M2A	300 volts
Inlet Water Temperature, S10A	Maximum 150 degrees F.
Outlet Water Temperature, S9A	Maximum 165 degrees F.
Water Pressure, Q1A*	

*The value of the water pressure will vary in different installations. It should be determined when the installation of the transmitter is completed.

No. D-85487 RECTIFIER UNIT (UNIT B)

Filament Voltage, M4B	400 volts
Rectified Voltage, M5B	1,600 volts
Plate Current Tube No. 1, M3B	0.20 to 0.27 ampere
Plate Current Tube No. 2, M1B	0.20 to 0.27 ampere
Plate Current Tube No. 3, M2B	0.20 to 0.27 ampere

No. D-85488 RECTIFIER UNIT—UNIT C

Filament Voltage Tube No. 1, M8C	Adjusted to balance rectifier plate currents; Maximum not to exceed 400 volts.
Filament Voltage Tube No. 2, M8C	
Filament Voltage Tube No. 3, M8C	
Filament Voltage Tube No. 4, M8C	
Filament Voltage Tube No. 5, M8C	
Filament Voltage Tube No. 6, M8C	
Rectified Voltage, M7C	17,000 volts
Plate Current Tube No. 1, M1C	1.5 to 2.0 amperes
Plate Current Tube No. 2, M2C	1.5 to 2.0 amperes
Plate Current Tube No. 3, M3C	1.5 to 2.0 amperes
Plate Current Tube No. 4, M4C	1.5 to 2.0 amperes
Plate Current Tube No. 5, M5C	1.5 to 2.0 amperes
Plate Current Tube No. 6, M6C	1.5 to 2.0 amperes
Differential Pressure, Q1C, Q2C Venturi Tube U1C	*15 to 20 lb. per sq. in.
Differential Pressure, Q3C, Q4C Venturi Tube U2C	*15 to 20 lb. per sq. in.

*The differential pressure is the difference between the readings of the gauges at the throat and at the inlet orifice of the particular Venturi tube when both gauges indicate on the pressure side. If the gauge at the throat orifice of the Venturi tube registers vacuum instead of pressure, the reading should be added to the readings of the gauge at the inlet of the tube to determine the differential pressure.

No. D-85489 OSCILLATOR MODULATOR UNIT—UNIT D

Oscillator Plate Current, M4D	55 to 70 milliamperes
Oscillator Grid Current, M5D	0 to 3 milliamperes
	See Note under "g" page 109
Radio Frequency Amplifier Output Current, M2D	See curves pages 114 and 191
Audio Input Amplifier Plate Current, M7D	35 to 50 milliamperes

NO. D-85489 OSCILLATOR MODULATOR UNIT—UNIT D (CONT'D)

Audio Power Amplifier Plate Current, M9D	70 to 120 milliamperes
Radio Frequency Amplifier Plate Current, M6D	50 to 80 milliamperes
Modulating Amplifier Plate Current, M1D	70 to 90 milliamperes
Modulating Amplifier Grid Current, M8D	3 to 15 milliamperes
Modulating Amplifier Output Current, M3D	1 to 1.6 amperes
Temperature, Crystal No. 1	See Quartz Oscillator Calibration
Temperature, Crystal No. 2	See Quartz Oscillator Calibration

NO. D-85490 FIRST POWER AMPLIFIER UNIT—UNIT E

First Power Amplifier Plate Current, Front, M2E	140 to 170 milliamperes
First Power Amplifier Plate Current, Rear, M3E	140 to 170 milliamperes
First Power Amplifier Load Current, M1E	190 to 230 milliamperes

NO. D-85491 SECOND POWER AMPLIFIER TUBE UNIT—UNIT F

Leakage Current, M1F	Maximum not to exceed 10 milliamperes
Differential Pressure, Q1F, Q2F Venturi Tube U1F	*15 to 20 lb. per sq. in.

*Refer to Note under No. D-85488 Rectifier Unit.

NO. D-85492 SECOND POWER AMPLIFIER TUNING UNIT—UNIT G

Second Power Amplifier Plate Current, Front, M2G	0.55 to 0.95 ampere
Second Power Amplifier Plate Current, Rear, M3G	0.55 to 0.95 ampere
Second Power Amplifier Load Current, M1G	3 to 4 amperes

NO. D-85493 THIRD POWER AMPLIFIER TUBE UNIT—UNIT H

Differential Pressure, Q1H, Q2H Venturi Tube U1H	*15 to 20 lb. per sq. in.
Differential Pressure, Q3H, Q4H Venturi Tube U2H	*15 to 20 lb. per sq. in.

*Refer to Note under No. D-85488 Rectifier Unit.

NO. D-85494 THIRD POWER AMPLIFIER TUNING UNIT—UNIT I

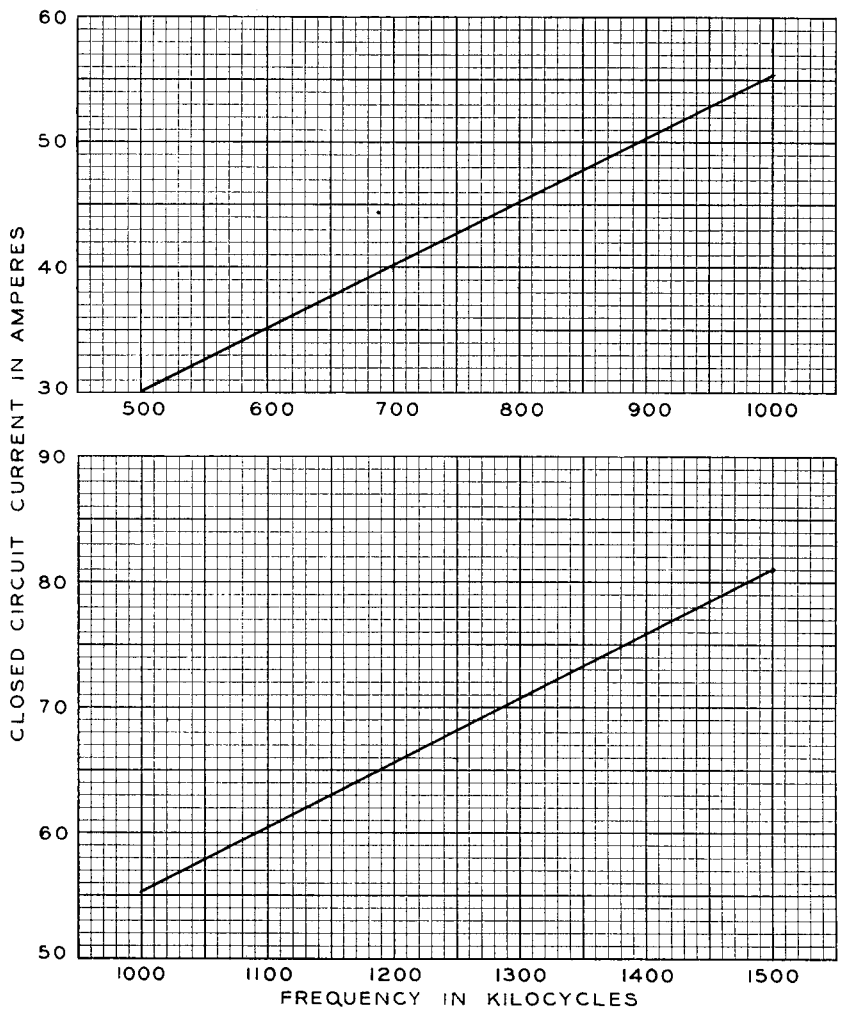
Third Power Amplifier Plate Current, Front, M1I	4 to 5 amperes
Third Power Amplifier Plate Current, Rear, M3I	4 to 5 amperes
Closed Circuit Current, M2I	See pages ~~110~~ and ~~190~~ 120 196
Transmission Line Current, M4I No. 1	9.6 amperes average for the two meters
Transmission Line Current, M5I No. 2	

NO. D-85495 ANTENNA COUPLING UNIT—UNIT J

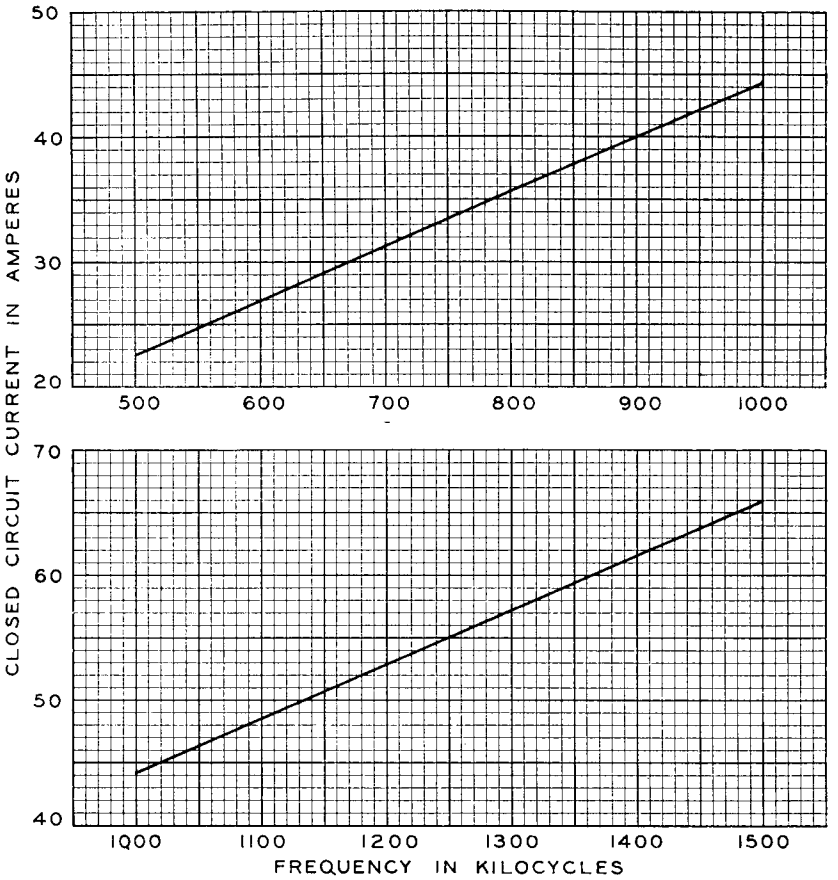
Transmission Line Current, M1J No. 1	9.0 to 9.6 amperes average for the two meters
Transmission Line Current, M2J No. 2	
Closed Circuit Current (Ind.), M3J	No limit specified except as required by current ratio curve, pages 118 and 195.
Closed Circuit Current (Cap.), M4J	See pages 113 and 191.

modulating amplifier by adjusting the "MODULATING AMPLIFIER TUNING" control until resonance is indicated by a maximum deflection on the "MODULATING AMPLIFIER OUTPUT CURRENT" meter. Neutralize the modulating amplifier by adjusting the "MODULATING AMPLIFIER BALANCING CONDENSER" control until a minimum deflection is obtained on the "MODULATING AMPLIFIER OUTPUT CURRENT" meter. Stop the transmitter.

j. Throw the handle of D5D up, open D8D and close D6D. Start the transmitter. Retune the modulating amplifier, this time adjusting it to minimum plate current. Turn the First Power Amplifier "BALANCING CONDENSER" control 10 degrees toward the maximum division mark. Tune the First Power Amplifier by adjusting the "1ST POWER AMPLIFIER TUNING" control until resonance is indicated by a maximum indication on the "1ST POWER AMPLIFIER LOAD CURRENT" meter. Neutralize the First Power Amplifier by adjusting the "BALANCING CONDENSER" control until a minimum deflection is obtained on the "1ST POWER AMPLIFIER LOAD CURRENT" meter. Stop the transmitter.



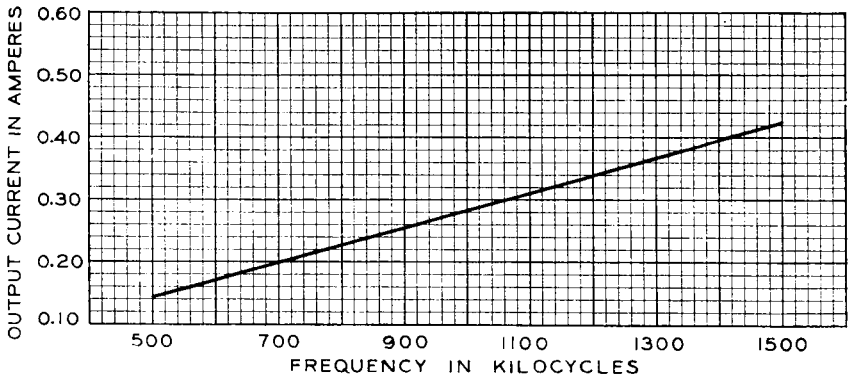
Closed Circuit Current in Third Power Amplifier Tuning Unit for 50 Kilowatts



Closed Circuit Current in Antenna Coupling Unit for 50 *Kilowatts*

k. Throw the handle of D3F up; close D2E. Start the transmitter. Adjust the 1,600-volt rectifier filament voltage to 400 volts and the plate voltage to 1,600 volts. Retune the First Power Amplifier, this time to minimum plate current. Adjust the "RADIO FREQ. AMPLIFIER INPUT" control to cause a deflection on the "RADIO FREQ. AMPLIFIER OUTPUT CURRENT" meter equal to that indicated by curve on pages 114 and 191. Adjust "1ST POWER AMPLIFIER INPUT" control to cause a deflection of 175 milliamperes on the "1ST POWER AMPLIFIER LOAD CURRENT" meter. Turn the Second Power Amplifier "BALANCING CONDENSER" control 10 degrees toward the maximum division mark. Tune the Second Power Amplifier by adjusting the "2ND POWER AMPLIFIER TUNING" control until resonance is indicated by a maximum indication on the "2ND POWER AMPLIFIER LOAD CURRENT" meter. Neutralize the Second Power Amplifier by adjusting the "BALANCING CONDENSER" control until a minimum deflection is obtained on the "2ND POWER AMPLIFIER LOAD CURRENT" meter. Stop the transmitter.

l. Disconnect links D8G from thermocouple H2G, throw switch D7G up, close safety switch D2A and turn the handles of the 17,000-volt rectifier filament rheostats in a clockwise direction as far as possible. Start the transmitter and press the "ON" button of the "17,000 V. RECTIFIER" switch, D4A. Retune the



Output Current of Radio Frequency Amplifier in Oscillator Modulator Unit

Second Power Amplifier by adjusting it to minimum plate current. Turn the Third Power Amplifier "BALANCING CONDENSER" control 10 degrees toward the maximum division mark. Tune the Third Power Amplifier by adjusting the "3RD POWER AMPLIFIER TUNING" control until a maximum deflection is obtained on the "CLOSED CIRCUIT CURRENT" meter. Neutralize the Third Power Amplifier by adjusting the "BALANCING CONDENSER" control until a minimum deflection is obtained on the "CLOSED CIRCUIT CURRENT" meter. Push the "OFF" button of "RECTIFIER CONTROL" switch D4B and disconnect the artificial antenna by opening switch D28I. Push the "ON" buttons of D4B, D2B and D4A successively. Check the tuning and the neutralization of the Third Power Amplifier. Stop the transmitter. Reconnect the artificial antenna by turning switch D28I to the "TEST" position. Disconnect links D16I and D17I from thermocouple H2.2I and connect them to the thermocouple H2.1I. Throw the handle of switch D14I to the right. Slide D3H and D4H down.

m. Start the transmitter. Retune the Third Power Amplifier, adjusting it to minimum plate current. Compute the value of the current ratio Ic, It where Ic =reading of the Third Power Amplifier "CLOSED CIRCUIT CURRENT" meter. It= the average value of the readings of the "TRANMISSION LINE CURRENT NO. 1" and "TRANSMISSION LINE CURRENT NO. 2" meters.

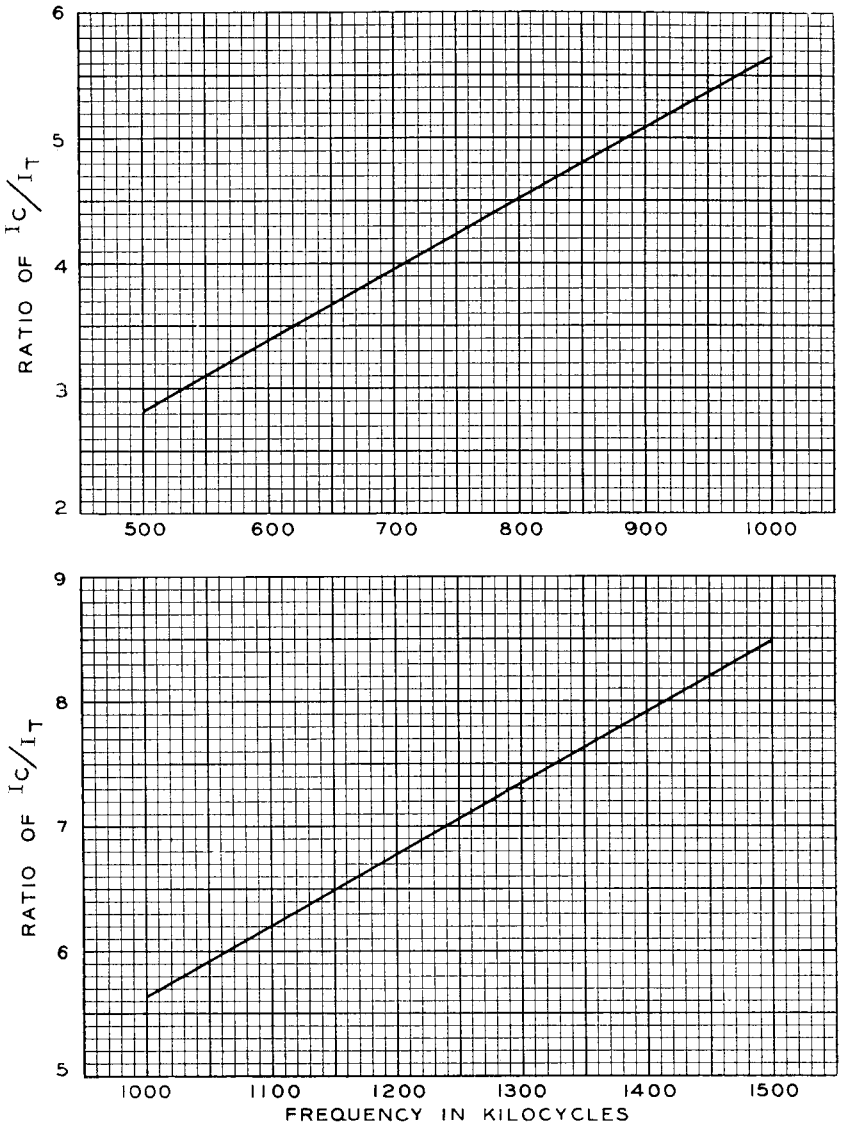
Compare its value with the required value of the ratio obtained from the curve on pages 115 and 192. Adjust "ARTIFICIAL ANTENNA TUNING" controls until the required value of the current ratio is obtained with the current approximately the same in both transmission lines. Stop the transmitter.

n. Change transformer primary switches D15P, D16P and D17P to tap No. 6. Start the transmitter and press the "ON" button of the "17,000 V. RECTIFIER" switch, D4A. Adjust the output to 50 kilowatts by means of the "1ST POWER AMPLIFIER INPUT," L6D, and the curve of transmission line current, pages 116 and 193. Adjust "RECTIFIED VOLTAGE" of D-85488 Rectifier Unit to 17,000 volts by means of switches D15P, D16P and D17P on the high voltage transformers and the filament rheostats on the Rectifier Unit. Using the most suitable taps on the high voltage transformers the filament rheostats should be employed to equalize the currents in the rectifier tubes and to make fine adjust-

ment of the rectified voltage. The filament voltage should approximate but not exceed 400 volts. Check the temperature adjustment of the No. D-87781 Quartz Oscillators. Check the tuning of all amplifier circuits. Stop the transmitter.

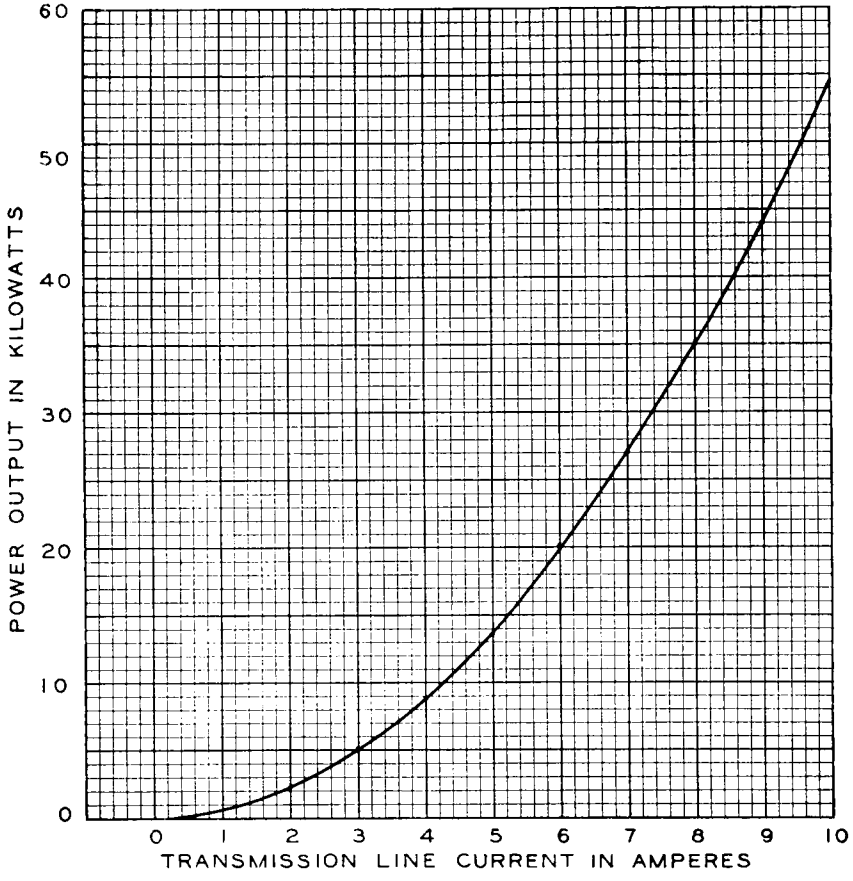
o. Connect D20I and D21I to L2.1I. Adjust the turns of L2.1I as indicated by the curve on pages 117 and 194. Place a wave meter adjacent to the right end of the Transmitter Assembly and connect between C20I and ground. Turn the control of the wave meter to a position which will make the wave meter circuit resonant to the highest frequency in the range of the wave meter.

NOTE: The range of the wave meter should include the second harmonic of the frequency assigned to the station.



Ratio of Condenser Current to Transmission Line Current—Six Tubes in Third Power Amplifier

Start the transmitter as indicated in paragraph n. Turn the control of the wave meter until a three-quarter scale deflection on the meter is obtained from the second harmonic of the transmitter frequency. Turn the "FILTER 1" control in a direction to reduce the deflection of the wave meter. Tune the wave meter until a suitable deflection is obtained from the second harmonic of the trans-



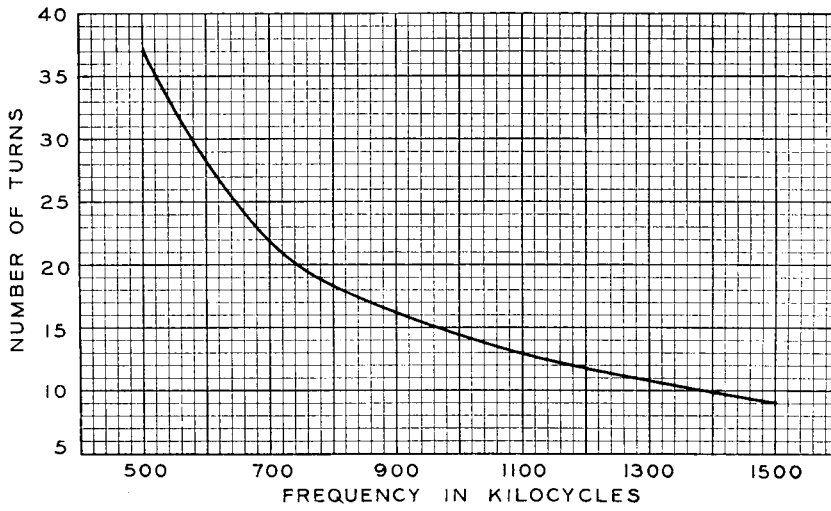
Output of Third Power Amplifier as Indicated by the Average of the Transmission Line Currents

mitter frequency. Repeat this procedure as necessary until the filter is adjusted so that a minimum deflection is obtained when the wave meter is tuned to the second harmonic. Stop the transmitter. Disconnect D20I and D21I from L2.1I.

NOTE: Be sure to note the number of the turn to which D20I is connected before removing it from the coil.

Connect D22I and D23I to L2.2I. Adjust the turns of L2.2I as indicated by the curve on pages 117 and 194. Change wave meter lead from C20I to C21I. Adjust this second harmonic shunt circuit in exactly the same manner as the first circuit was adjusted following the instructions given above. When the tuning of the second circuit is complete stop the transmitter. Connect D20I and D21I to

NOTE: Be sure to connect the clip D20I to the same turn of L2.1I to which it was connected when this circuit was first adjusted.



Adjustment of Harmonic Shunt Coils L2.1I and L2.2I

L2.1I. Remove the lead from C21I. Start the transmitter. Check the tuning of the Third Power Amplifier. Stop the transmitter.

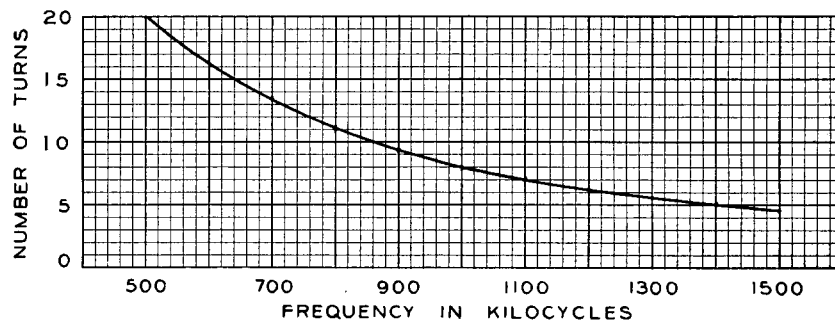
p. Change switches D15P, D16P and D17P to tap No. 1. Reduce "1ST POWER AMPLIFIER INPUT" control, L6D to 0. Turn D28I to "TRANSMIT." Disconnect Clip D10J from the antenna coupling coil L2J. Adjust the turns of coil L1J as indicated by the curve shown below and on page 194.

NOTE: The number of turns indicated is the total; they should be divided equally about the center of the coil.

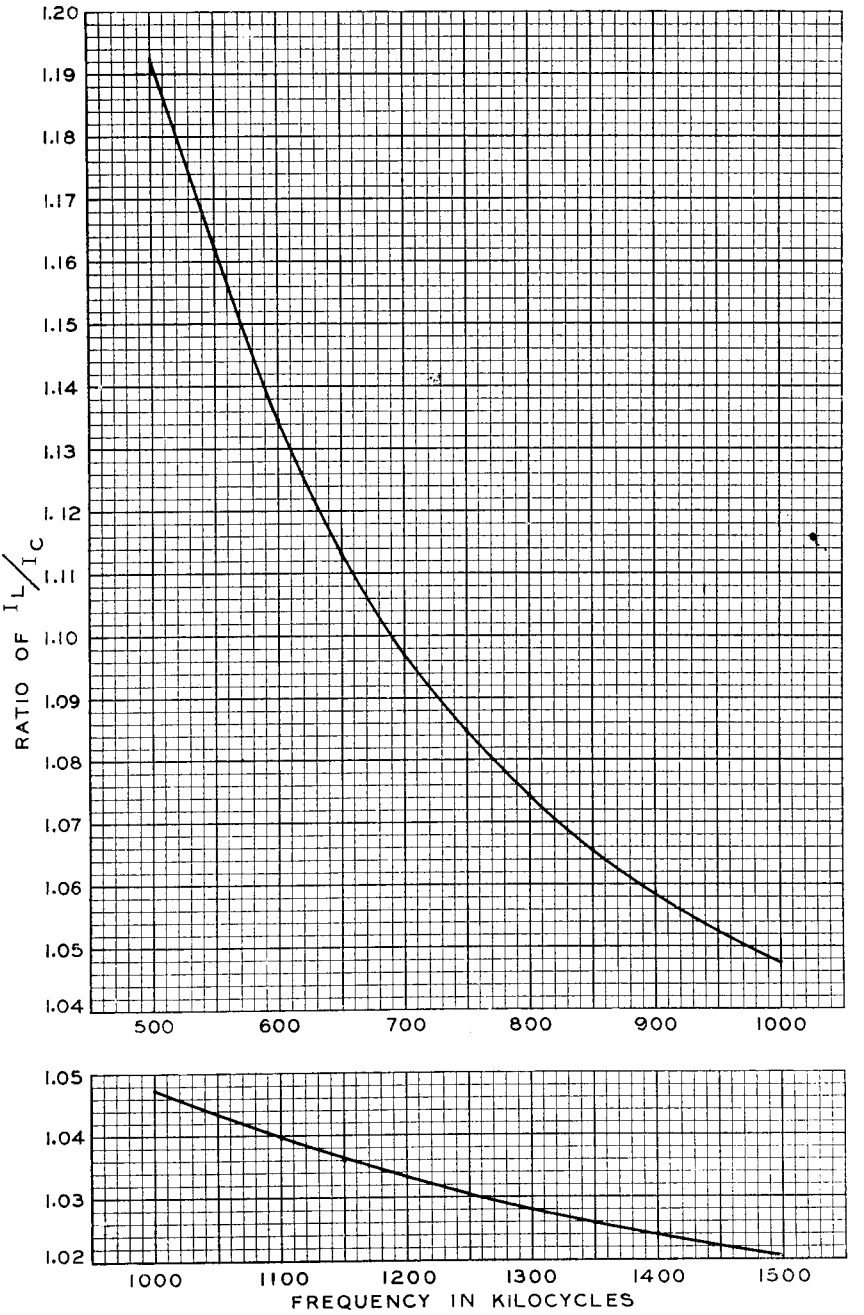
Short-circuit the unused end turns of L1J with D6J, D7J, D8J and D9J. Start the transmitter. Compute the current ratio IL/IC.

where: IL=the reading of the "CLOSED CIRCUIT CURRENT (IND.)" meter M3J

IC=the reading of the "CLOSED CIRCUIT CURRENT (CAP.)" meter M4J.



Adjustment of Coil L1J in Antenna Coupling Unit



Ratio of Inductance Current to Capacity Current in Antenna Unit—Antenna Disconnected

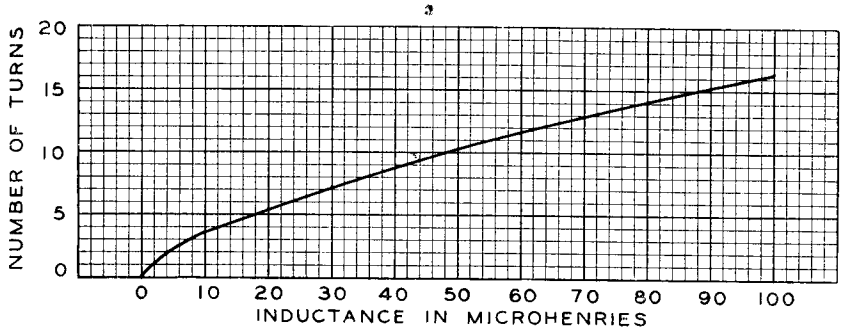
Compare the value of the ratio with the required value as indicated by the curve on pages 118 and 195.

NOTE: If a midscale reading is not obtained on these meters, increase the power output from the transmitter until suitable readings are obtained. Be careful not to overload the thermocouples in these circuits by making the pointers on the meters go off the scales.

Adjust L1J until I_L/I_C equals the required value.

NOTE: If the computed value of the ratio is too great increase the number of turns in L1J and conversely if the value of the ratio is too small reduce the number of turns in L1J.

Stop the transmitter.



Inductance of Antenna Loading Coil L3J

q. With the known data on the capacity of the antenna compute the value of the inductance required to resonate the antenna at the transmitter frequency. On the basis of the computed value of the inductance and the curve shown above and on page 196 adjust the turns of L3J to obtain the required inductance.

NOTE: The number of turns indicated is the total; they should be divided equally about the center of the coil.

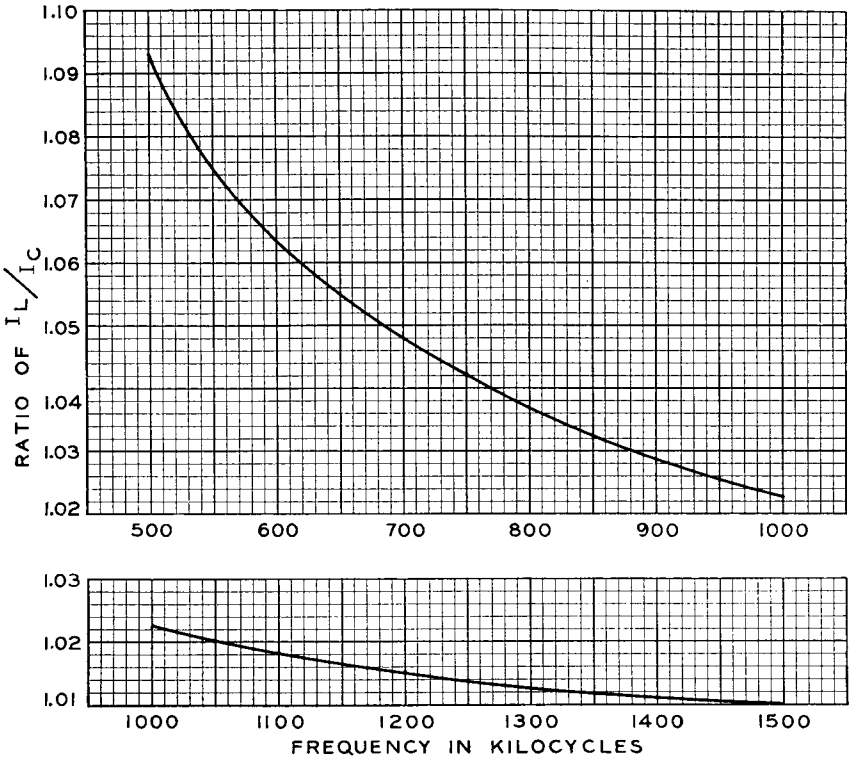
Short-circuit the unused turns of L3J with D11J, D12J, D13J and D14J. Connect three turns of L2J in the circuit. Operate D6N so as to connect the antenna to the "TRANSMIT" position. Start the transmitter.

NOTE: Increase the power output from the transmitter by adjusting the "1ST POWER AMPLIFIER INPUT" control until suitable readings on all antenna coupling circuit meters are obtained.

Tune the antenna circuit by means of the "ANTENNA TUNING" control until the required value of the current ratio I_L/I_C as indicated by the curve on pages 120 and 196, is obtained.

NOTE: If the correct value of the ratio is not obtained within the limits of the inductance variation caused by turning the closed ring in the field of L3J stop the transmitter and change the number of turns of L3J in the antenna circuit. If the ratio is low increase the number of turns in the antenna circuit, or, if the ratio is high decrease the number of turns in the antenna circuit.

If the correct value of the current ratio I_L/I_C is being approached as the closed ring is turned from a vertical position to a horizontal position the number



Ratio of Inductance Current to Capacity Current in Antenna Unit—Antenna Connected

of turns should be decreased. Conversely if the correct value of the ratio IL/IC is being approached as the closed ring is turned to a vertical position the number of turns should be increased. Compute the value of the current ratio IC/IT.

where: IC=the reading of the "CLOSED CIRCUIT CURRENT (CAP.)" meter

IT=the average value of the readings of the "TRANSMISSION LINE CURRENT NO. 1" and "TRANSMISSION LINE CURRENT NO. 2" meters.

Compare the computed value of the current ratio with the required value of the ratio obtained from the curve on pages 121 and 197.

NOTE: If the value of the computed current ratio IC/IT is less than the value of the ratio obtained from the curve the inductance of L2J should be reduced. Conversely, if the value of the computed current ratio IC/IT is greater than the value obtained from the curve the inductance of L2J should be increased.

Continue the adjustments of the antenna coupling circuits until both current ratios IL/IC and IC/IT have their required values simultaneously.

r. Compute the current ratio IC/IT at the Third Power Amplifier. Modify the adjustment of the Antenna Coupling Unit slightly until the current ratios

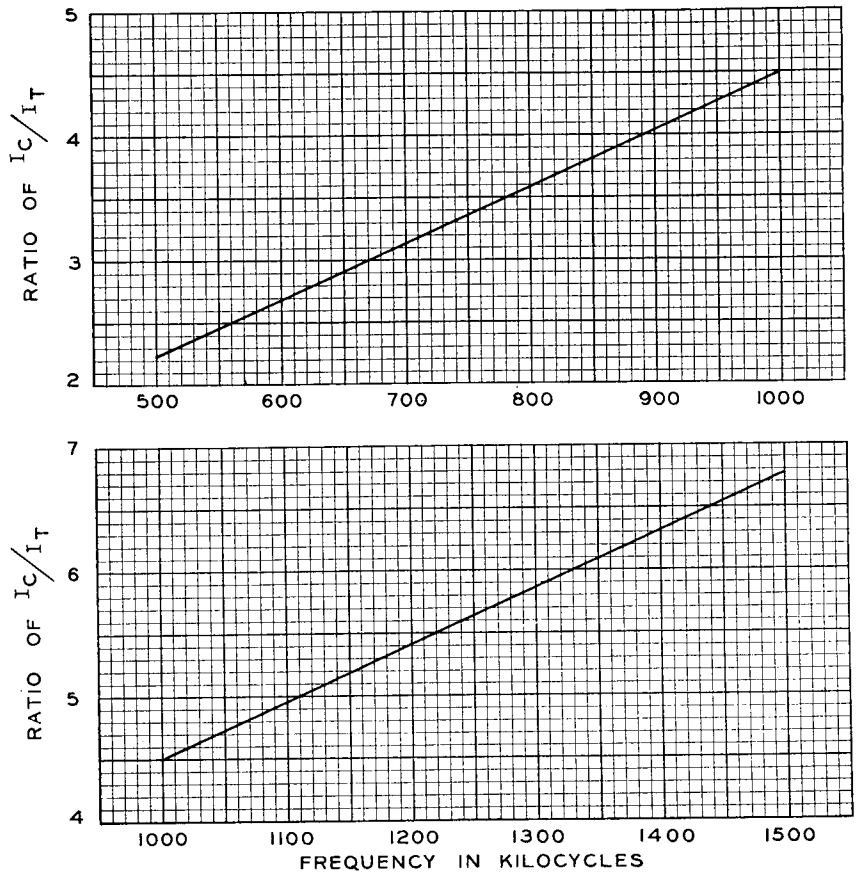
I_L/I_C (at the Antenna Coupling Unit) and I_C/I_T (at the Third Power Amplifier) are both equal to the required values simultaneously. Stop the transmitter.

s. Change the primary switches D15P, D16P and D17P on the high voltage transformers to the tap on which 17,000 volts was obtained during the adjustments in paragraph n; start the transmitter and adjust it as described in that paragraph. Adjust all filament and plate voltages to normal values. Check the tuning of the complete radio frequency circuit. Increase the power output until the average value of the transmission line current is equal to 9.6 amperes.

NOTE: Short circuit all unused turns of the First and Third Power Amplifier tuning inductances by means of the clips provided. In the Third Power Amplifier Tuning Unit the adjustments indicated for L1I are for the coils supplied for use from 900 kilocycles to 1,100 kilocycles or from 1,100 kilocycles to 1,500 kilocycles. The Second and Third Power Amplifier Tuning Units require an equal number of turns of the tuning inductance on each side of their respective mid-point connections. The fixed balancing capacitance specified is used on both sides of the balancing circuit in the Second and Third Power Amplifier Tuning Units.

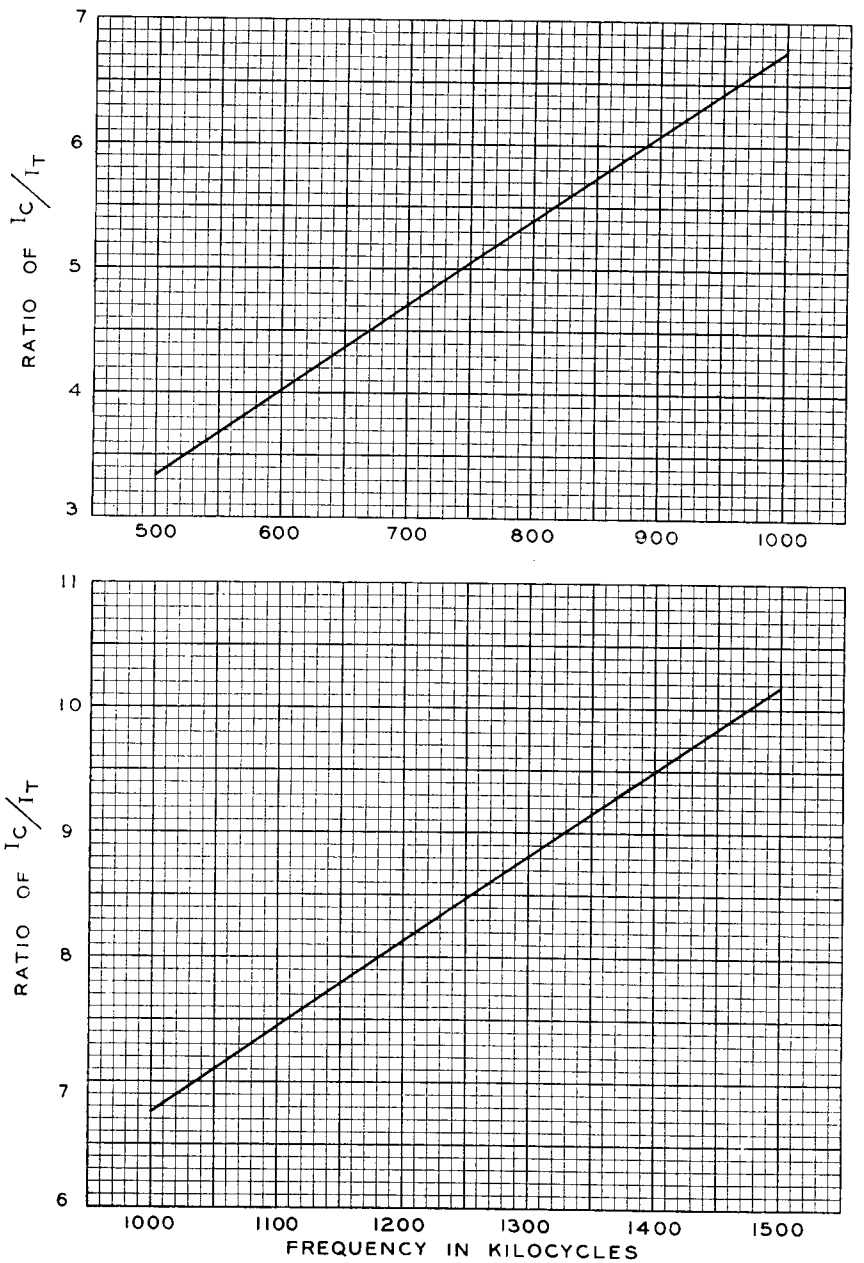
Monitoring Rectifier.

If an oscillograph is to be used, adjustment for the desired deflection should

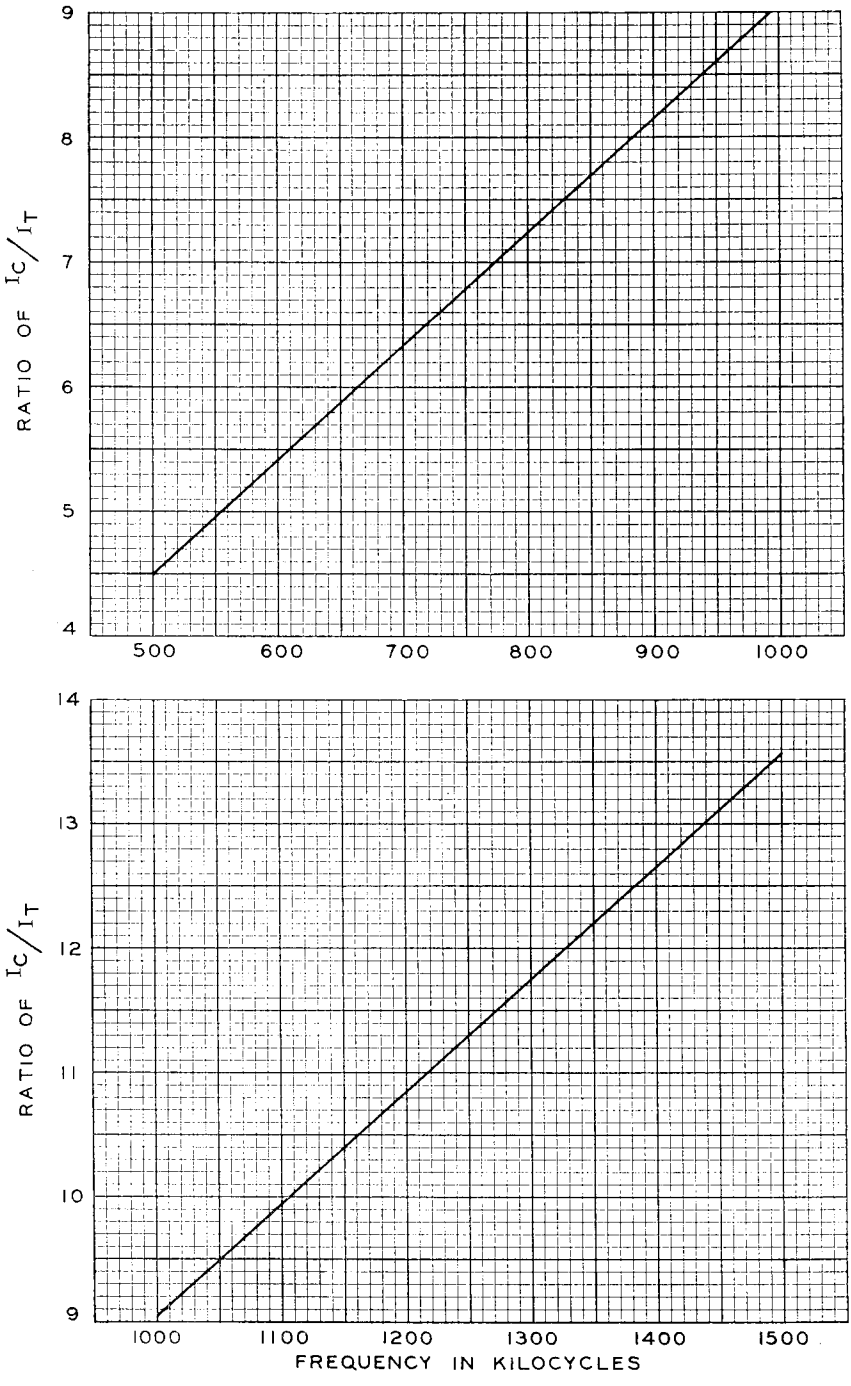


Ratio of Condenser Current to Transmission Line Current—Antenna Coupling Circuit

be made by means of D25I and the tap lead from C18I to C17I. To vary the audio frequency output of the rectifier, D26I and D27I are provided. D26I and D27I should be adjusted to give a somewhat higher input to the monitoring amplifier than is obtained from the input to the transmitter, fine adjustment being made by the potentiometer provided in the speech input equipment.



Ratio of Condenser Current to Transmission Line Current—Four Tubes in Third Power Amplifier



Ratio of Condenser Current to Transmission Line Current—Two Tubes in Third Power Amplifier

TABLE V—ADJUSTMENTS FOR REDUCED POWER

(Switch numbers given below are shown in drawings on pages 82, 180 and 182.)

Number of Tubes in Third Power Amplifier	6	4	2
Antenna Power in Kilowatts	Maximum 50	Maximum 30	Maximum 15
Coupling Capacitance (Total)	0.0015 mf.	0.0018 mf.	0.0024 mf.
Switch D7.5I	Open	Closed	Closed
Switch D7.4I	Open	Open	Closed
Switch D7.3I	Open	Open	Closed
Switch D7.2I	Open	Open	Open
Switch D7.1I	Open	Open	Open
Switch D8.5I	Open	Closed	Closed
Switch D8.4I	Open	Open	Closed
Switch D8.3I	Open	Open	Closed
Switch D8.2I	Open	Open	Open
Switch D8.1I	Open	Open	Open
Fixed Neutralizing Capacitance (Value for Each Side)	0.00015 mf.	0.00009 mf.	0.00003 mf.
Switch D1I	Closed	Closed	Closed
Switch D2I	Open	Closed	Open
Switch D3I	Closed	Open	Open
Switch D4I	Closed	Closed	Closed
Switch D5I	Open	Closed	Open
Switch D6I	Closed	Open	Open
Current Ratio Ic/It	Use Curve pages 115 and 192	Use Curve pages 122 and 198	Use Curve pages 123 and 199

If the connection to C17I is not determined by the requirement of an oscillograph D26I and D27I should be connected to give maximum audio frequency output, that is, with all of R4I and R5I connected in circuit. Adjust C17I to the lowest tap which will give the output required for monitoring.

ADJUSTMENT OF CIRCUITS AND TUNING PROCEDURE FOR REDUCED POWER

The No. 7-A Radio Transmitter may be adjusted to obtain an output power less than 50 kilowatts, by reducing the input to the First Power Amplifier or by reducing the number of tubes in the Third Power Amplifier.

With less than six tubes in the Third Power Amplifier C5I and C6I must be increased and the capacitance of the neutralizing condensers must be decreased. The tuning and neutralizing procedure is the same as for 50-kilowatts power output except that the current ratio Ic/It changes when four or two tubes are used. The adjustments of the Third Power Amplifier for reduced output are given in Table V. Use curve on pages 116 and 193 to determine transmission line current required. Intermediate values and final adjustments of output are obtained by adjusting the First Power Amplifier Input controls.

Operating Routine

The following is the operating procedure to be followed after the transmitter has been properly adjusted as described under ADJUSTMENT OF APPARATUS AND CIRCUITS. The routine followed will of course depend to some extent on local conditions.

Starting Procedure

Before attempting to start the transmitter the operator should make a thorough inspection of the unit assemblies and the power apparatus and pump rooms, observing the condition of the conductors, the positions of switches, whether water leaks have occurred and particularly determine whether a person may be inside any of the enclosures.

The daily maintenance routine should be completed insofar as it is necessary before the transmitter is started at the beginning of a daily operating schedule.

The warming up operation of the transmitter before the transmission of program signals should be made with the transmitter connected to the artificial antenna unit. In the interval between the end of warming up period and the beginning of the program the operator should be sure to operate the "OFF" button of the "17,000 V. RECTIFIER CONTROL", D4A, then operate the transfer switch D28I so that the transmitter is connected to the transmission lines, and also to operate the antenna grounding switch D6N, so that the antenna is connected to the transmit terminal. The "ON" button of the "17,000 V. RECTIFIER CONTROL" may then be pressed and the program started.

Full details of the starting operations of the transmitter have been given and need not be repeated here.

Semi-Automatic Starting.

To obtain semi-automatic starting the "OFF" button of "RECTIFIER CONTROL" switch D4B is pressed first and following that the "ON" button of the "MASTER CONTROL" switch D4A. This starts all motors and applies voltage to the filaments and grids of the vacuum tubes.

NOTE: Semi-automatic starting is recommended for the warming up period as the water flow and filament grid voltages may be checked before the plate voltage is applied.

After starting relay S7A has operated, the "ON" button of D4B may be pressed, and the plate voltages applied when desired by pressing the "ON" buttons of "1,600 V. RECTIFIER" and "17,000 V. RECTIFIER" switches D2B and D4A.

Automatic Starting.

Automatic starting is obtained by pressing the "ON" button of the "MASTER CONTROL" switch D3A providing "RECTIFIER CONTROL" switch D4B is in the "ON" position. The plate voltages are applied automatically 20 seconds after the filament voltage has been applied to the tubes, making it necessary to have all the voltages adjusted for normal operation before automatic starting is attempted.

Warming Up Period

Start up the motor generators 30 minutes before it is expected to go on the air, in order that the machines may come up to operating temperature before the program starts. This will make it unnecessary to check the filament and grid bias voltages so often during the first part of the program. During this warming up process, it is advisable to apply the plate voltages in order to check all meter readings. This will also give the operator a chance to adjust the power output to the required value ("1ST POWER AMPLIFIER INPUT" control) and the plate voltages to compensate for changes in line voltage. In order to make small changes in the output voltage of the 17,000-volt rectifier the filament voltages of the rectifier tubes may be changed, provided that they are not operated at a voltage greater than 400 volts.

During the warming up period both Crystal Oscillators should be tested to see that they are working properly.

Station Routine

The No. 7-A Radio Transmitter is a complex arrangement of coordinated circuits and apparatus and should have proper care and attention from the operating personnel. A station log book used consistently is an excellent aid in maintaining regular routine.

MAINTENANCE

GENERAL

For best operation the transmitter must be kept free from dust and dirt. High pressure air is recommended for cleaning the apparatus inside the enclosure, but a soft clean cloth may be used with good results. Waste or oily cloth should never be used. Lemon oil is recommended for cleaning the front of the panel units. It should be used sparingly and wiped off with a soft cloth.

Nuts, bolts and screws should be examined occasionally and loose ones tightened. Also examine all electrical connections and tighten loose contacts if any are found. Trouble can often be prevented by such precautions.

Tubes should never be operated at higher potentials than those specified, as such operation shortens the life of the tubes and does not improve the operation of the equipment.

Two or three times a year lower the antenna and clean the insulators thoroughly. Inspect the contacts and tighten nuts and bolts. It is important that the antenna insulators be cleaned periodically especially if there is much smoke in the air. Where smoke exists, soot collects on the insulators and produces high resistance ground leaks which reduce the efficiency of the antenna.

If it should be necessary to clean the crystal in a No. D-87781 Quartz Oscillator, it may be done with carbon tetrachloride and lens paper or other lintless material. Should an occasion arise to ship the quartz oscillator care should be taken to suitably pad the crystal, as well as the complete quartz oscillator unit, before making the shipment.

POWER EQUIPMENT

All of the power equipment should be kept clean and in first class operating condition. Wipe off dust, dirt and excess oil with clean soft dry cloths. The commutators of generators should be kept clean and polished. The brushes should be wiped off frequently and the brush tension adjusted as the brush wears away. The bearings of all rotating machines should be well lubricated at all times. To obtain the required lubrication the oil rings should be in place and turn freely when the machine is in operation.

The insulating oil in plate transformers, filter retard coils, interphase reactor and filament transformers should be inspected regularly. For detailed information see "Maintenance Schedule".

The No. 100-A Condensers require little or no maintenance. If the installation instructions which are packed with each condenser have been carefully followed, and if the condensers are operated at normal temperatures and rated voltage.

These condensers should be installed in a place where there is free circulation of air, and where the room temperature may be maintained between 40 degrees F. and 105 degrees F. They should be used only on direct current

circuits and operated at potentials not exceeding 33 volts. If it is necessary to disconnect a condenser from the circuit for more than one week, the film on the positive plate may deteriorate. To prevent this, the condenser should be connected across a source of normal operating voltage for one or two hours each week that it is out of service.

When a condenser has not been maintained in this manner it may pass a high current and give off gas when potential is applied. If the cell is in this condition it will be necessary to refilm the positive plate before putting a condenser back into service. This process is an emergency measure only and should not be substituted for weekly maintenance while the condenser is out of service, for allowing the film to deteriorate shortens the life of these cells. The refilming may be done by connecting the condenser in series with a 110-volt lamp rated between 50 and 100 watts across a supply of direct current having a potential equal to or slightly greater than that of the circuit in which the condenser is used. Care should be taken in doing this to be certain that the positive terminal of the condenser is connected to the positive side of the source of potential. The condenser should be allowed to remain connected in this circuit until the current flowing through it drops to a value of 50 milliamperes or less. This may, in some cases, take one or two days.

Care should be taken to keep the hole in the porcelain cover plugged with a cork and to have the groove of the cover set properly over the rim of the glass jar, the paraffin in the grooves maintaining the seal. Unless the air space above the oil is sealed to prevent air circulation, crystals from the evaporation of creeping condenser fluid will form on the supports above the oil.

Occasionally a gray precipitate will appear at the bottom of the jar. This is the result of a corrosive action which takes place on the positive or corrugated plates and their terminals. Such a corrosive attack is particularly likely to take place if sufficient care has not been exercised in the installation of the condensers. The attack is not harmful unless the terminals of one of the positive plates are weakened sufficiently to allow the plate to drop against the negative structure. In the event of a short circuit of this nature, the condenser plates can be removed from the fluid, the remaining supports of the affected plate cut-off, and the damaged plate removed. The remaining electrodes may then be used until a new condenser is obtained. The change of capacity due to the removal of one electrode is not sufficient to affect the filtering action of the circuit in which the condenser is connected, and after a plate has been removed the condenser may continue to operate indefinitely. However, the corrosive action may continue so that additional plates must be removed, in which case the filtering action of the circuit would be materially affected.

Water Cooling Equipment

The Water Cooling System should be inspected for leaks at all pipe joints, valves, rubber hose connections and in the radiators. Whenever a leak is detected it should be stopped as soon as possible in order to avoid the development of further trouble. The flow of water through the tube jackets should be checked at

regular intervals, as it is possible that the hose coils may deteriorate with age and cause the flow of water through them to be reduced gradually. New hose should be installed when the differential pressure has fallen to 12 pounds or less.

The level of the water in the expansion tank should always be maintained at the cold water level when the water is at room temperature as described in paragraph "i" on page 102. It is important to keep the storage tank well filled either by the filling process described on page 102 or by pouring additional water in it through the emergency filling funnel. The latter operation can be done while the transmitter is in operation.

If it should become necessary to drain the water from the Water Cooling System temporarily, the water may be permitted to flow back into the drain tank by opening valves Y18W and Y19W. Valves Y31W and Y32W should be kept closed. The water in the drain tank can be returned to the circulating system by the procedure described at the bottom of page 101.

If the conductivity of the cooling water becomes sufficient to cause the leakage current to amount to 10 milliamperes or more as shown on meter M1F in the Second Power Amplifier Unit, it should be drained from the system and replaced by fresh distilled water. The water may be drawn from the circulating system for the complete replacement of new water by opening all valves except Y31W and Y32W. This will allow the water to flow off into the waste system through valve Y38W. Valve Y38W should then be closed and the water in the storage tank should be permitted to flow back into the drain tank by opening valves Y19W and Y32W. The system should be refilled in accordance with the instructions given at the bottom of page 101.

Water-Cooled Tubes

When a new tube is received first read the attached instruction sheet and then remove the tube from its shipping case and give it a thorough inspection to make sure that there are no cracks in the glass. If such a crack is found the tube should be returned to the nearest Western Electric Distributor house along with the proper forms. Do not apply filament voltage to such a tube. Occasionally a tube will be found with small fragments of brown material loose inside. This does not indicate that the tube is defective. After the visual inspection the 10 minute operating test should be given it as directed by the instruction sheet.

Maintenance Schedule

In order that the No. 7-A Radio Transmitter may be maintained in the most efficient operating condition, it is suggested that the following routine be adopted.

Daily.

Clean the front panels of the Transmitter and Rectifier Assemblies.

Bring up the level of the cooling water in the expansion tank to the cold water mark. Do this before starting the transmitter.

Inspect all water-cooled tube jackets and water connections to make sure there are no leaks. It is advisable to do this with the pump in operation.

Crystals No. 1 and No. 2 should be used on alternate days in order to make sure they are both operative.

The life of the water-cooled tubes may be prolonged by reversing the filament current through them at regular intervals. D1F and D1H are provided for this purpose. It is suggested that the polarity be reversed at the beginning of each day of transmission.

During operation it is advisable to keep a log of meter readings and it is suggested that these readings be taken every thirty minutes. This does not mean that the set may be left unattended for 30 minute periods.

Weekly.

The commutators of the grid bias generator and the filament generator should be cleaned with a cloth to remove oil and dust and polished with a piece of heavy canvas. Do not use emery or crocus cloth to smooth the commutator.

Oil the bearings of all rotating equipment. Keep the oil level up to the top of the oil drain outlets.

Turn down the caps of the grease cups on the water pump one complete turn.

After a long run, open the main power disconnect switch in the generator room and then feel the clip and hinge contact surfaces of all the main power switches and fuses. If any of the parts are hot, the tension of the clips should be adjusted and the contact surfaces cleansed with fine sandpaper.

Monthly.

Tighten all bolts, nuts and screws, particularly terminal strip nuts, flexible connections to filament of tubes, radio frequency coil connections, and bolts on the condensers in the Third Power Amplifier Tuning Unit and the Antenna Coupling Unit.

Clean contacts of magnetic switches by lightly filing or grinding down the contact surfaces.

A sample of oil from the plate transformers, filter retard coils, interphase reactor and filament transformers, should be tested for breakdown in accordance with specification No. D117-27 found in the Standards of the American Society for Testing Materials Part 2. This test should be made about twice a month at first, in order to determine the rate at which the dielectric strength decreases. This will depend largely upon humidity and the schedule upon which the station operates. The frequency at which these tests are finally made will depend upon the rapidity with which the breakdown of the oil falls off but should in no case be at intervals greater than one month. When the breakdown of the oil as determined by these tests falls below 16,000 volts r.m.s. the oil should be dried.

The oil level in all oil filled transformers and retard coils should be brought up to the normal oil level mark on the oil level gauge.

Clean the contacts of all power control circuit relay contacts with crocus cloth by drawing a narrow strip between the contacts, pressing the contacts together with the cloth between them.

Clean the contacts of the temperature control relays S3D and S4D and the thermostats S1D and S2D with carbon tetrachloride being careful not to disturb their adjustment and also not to get any of the liquid on the rest of the apparatus.

Clean and polish the spark gap balls of the 17,000-volt rectifier protective gaps.

Wipe off all high voltage porcelain insulators with a clean dry cloth, particularly those in the 17,000-Volt Rectifier Unit, the Second and Third Power Amplifier Units and in the Transformer and Filter Assembly.

Clean the water strainers on the inlet side of the pumps.

Check the time delay adjustment of S7A and S8A.

Inspect the hose couplings to determine whether electrolytic corrosion has extended to a point where the couplings should be replaced.

Check the packing of the pump shaft glands, tighten the gland nut if water leaks through the packing and put in new packing if needed.

Check the condition of the graphite or carbon resistance rods. Clean the end with a dry cloth and replace any rod with corroded copper ends with a new rod.

Check the brush tension on the filament and grid voltage generators.

LOCATION OF TROUBLE

When trouble occurs in any circuit of the transmitter it may be possible to determine the cause immediately from the nature of its manifestation. On the other hand the cause may be so obscure that only a careful and detailed search will find it.

The transmitter may fail to function either at the time of attempting to start it or it may fail while it is in operation. If the cause is not immediately apparent, the time required to find the cause of the trouble will be reduced to a minimum if a systematic procedure of testing is used, instead of a trial and error method. The following systematic procedure should be followed when trouble occurs.

Whether the transmitter fails to function when starting or in operation the procedure for making the test is to check the circuits in the sequence they are made operative in the process of starting the transmitter. The tests should be made in the following order which corresponds to the normal starting procedure.

FAILURE TO START

First Starting Operation.

Press the "OFF" button of D4B. Press the "ON" button of D3A and check operation of the following circuits:

Power Supply Circuits. (Pages 12 and 148)
Control Circuits, Safety Door Switches. (Pages 13 and 149, 14 and 150, 16 and 151, 18 and 152, and 20 and 153)
Flow of Cooling Water. (Pages 96 and 188)
Filament Generator Circuits. (Pages 30 and 157)
Negative Biasing Potential Generator Circuits. (Pages 32 and 158)
Fan Motor Circuits. (Pages 8 and 147)

Second Starting Operation.

Press the "ON" button of D4B. Press the "ON" button of D2B and check operation of the following circuits:

Control Circuits. (Pages 13 and 149)
1,600-volt Rectifier Unit. (Pages 42 and 164)
Oscillator-Modulator Unit. (Pages 54 and 170)
First Power Amplifier [redacted] Unit. (Pages 62 and 172)

Third Starting Operation

Press the "ON" button of D4A and test the following circuits:
Control Circuits. (Pages 13 and 149)
17,000-Volt Rectifier Unit. (Pages 48 and 166)
Second Power Amplifier Tube Unit, and Second Power Amplifier Tuning Unit. (Pages 66 and 174 and 72 and 176)
Antenna Coupling Unit. (Pages 88 and 184)

The items listed under each of the starting operations represent distinct circuits or units which may be isolated and tested by means of the switches and meters provided for this purpose.

Defective Vacuum Tubes

Overload Relays.

Should any of the tubes cease to function properly, one or more of the overload relays associated with them may operate, tripping magnetic contactors S1B and S12A and thus cutting off the plate power supply.

17,000-*Volt Rectifier*—When the 17,000-volt rectifier tubes cease to function properly, it usually causes such an excessive current to be drawn by the plate transformers associated with them that one or both of the primary overload relays S3C and S4C may be caused to operate. The overload relay S2C in the plate circuit of the tubes may operate before S3C or S4C as these two relays are time delay relays. S2C may also be caused to operate by reason of one or more of the No. 232-A Amplifier Tubes being defective although the overload relay associated directly with these tubes will probably operate first.

1,600-*Volt Rectifier*—The overload relays associated with the 1,600-Volt Rectifier may be caused to operate either by a defective rectifier tube or by a defective radiation-cooled amplifier tube. The operation of S5B, S6B or S7B indicates that one of the rectifier tubes is probably defective; S4B may also be caused to operate and should it operate alone, the trouble is probably due to a radiation-cooled tube in the Transmitter Assembly.

Second Power Amplifier—A defective tube in the Second Power Amplifier may cause either relay S1F or S2F to operate. If one of these relays continues to operate persistently, it is an indication that the tube in whose plate circuit it is located is defective or that its circuit is defective.

Third Power Amplifier—A defective tube in the Third Power Amplifier may cause either relay S3H or S4H to operate, indicating where the tube is located. Sometimes the tube may be identified by watching for a flash to occur inside the tube when the power is turned on.

Gassy Tubes.

The presence of gas in a tube usually manifests itself when the voltage is first applied by a pink or purple haze, inside the tube. Sometimes no visual indication of gas in a tube can be noted. In this case, it is at times possible to locate a defective tube by looking for a bright flash to occur inside the tube when the power is turned on.

Rectifier Tubes—In the case of the rectifier tubes if the haze is of a light purple color, it may be possible to clean up the gas temporarily by reducing the voltage applied to the rectifier by means of the taps on the plate transformers and applying the voltage several times until the haze disappears. Even though the gas be disposed of in this manner, it is very likely that the tube will give trouble later.

No. 232-A Amplifier Tubes—Should a gassy amplifier tube be noticed it should be replaced by a good tube as soon as possible.

No. 248-A and No. 212-D Tubes—A fluorescence in any of the radiation-cooled tubes is not an indication that the tube is defective.

Grid-to-Plate or Grid-to-Filament Short Circuits

These short circuits sometimes occur in the amplifier tubes. In either case, there will be practically a short-circuit placed on the grid bias generator and the cause of the trouble may be determined at once because the grid voltage will be nearly zero. The faulty tube may be found by means of a buzzer test set, testing between grid and filament and between grid and plate with the grid and filament leads removed.

Open Filament.

An open filament is evidenced by the tube not lighting, but in the case of the No. 212-D Tubes which have two filaments in parallel if one filament only is open, the tube will still light. A low plate current will be the result of this defect.

Short Circuit in Rectifier Tube.

17,000-*Volt Rectifier Tubes*—Should a short circuit occur overload relay S2C will operate and shut off the high voltage. The defective tube may sometimes be located by observation of the tubes when power is applied to all of them. If this is not possible, segregation of the tubes for observation may be accomplished by opening the tap switch on one or two of the high voltage transformers and applying power to either four or two of the rectifier tubes at a time. The search for the trouble may in this way be narrowed to a consideration of only two tubes and if definite location of it is still not possible the filaments of these two tubes may be disconnected one after the other and by applying plate voltage to each independently the defective tube is located.

1,600-*Volt Rectifier Tubes*—Should one of the 1,600-volt rectifier tubes be short-circuited, the tube may be located by the bright flash that will occur inside it when the power is turned on.

Poor Audio Quality

The distortion resulting from over modulation should not be confused with the distortion that results from incorrect circuit adjustments. The later form of distortion will occur with normal modulation.

A listening test for distortion should be made at regular intervals. By means of the monitoring rectifier in the Third Power Amplifier Tuning Unit the program is available at the output of the transmitter in nearly the same form that it is received by a listener using a radio receiver. The listening test is made by comparing the program at the input of the transmitter with the program from the monitoring rectifier using the same amplifier and loud speaker. The volume from the loud speaker should be adjusted, by means of the potentiometer provided for that purpose in the speech input equipment, to be the same from either circuit.

A comparison of the quality is made by operating the key, which connects the loud speaker first to the input and then to the output of the monitoring circuit and at the same time listening critically to the loud speaker. Both speech and music should be used for this comparison.

If distortion is observed in the output, check the level of the program at the input of the transmitter. If the input level is not excessive it is possible that the circuit is adjusted incorrectly and the following tests should be made.

Supply Voltages.

The various supply voltages should be as close to the recommended values as possible.

Filament	20 volts
Grid Bias	300 volts
Plate Supply, Unit B	1,600 volts
Plate Supply, Unit C	17,000 volts

Load Impedance of the Third Power Amplifier.

It is necessary that the transmitter work into the proper load impedance. This is indicated by having the proper ratio of Ic/It as shown by the curve on pages 115 and 192. This impedance is determined by the tuning of the antenna coupling unit, or in case of the artificial antenna by the adjustment of the tuning coils L1K and L2K.

An incorrect adjustment of L1I in the Third Amplifier Tuning Unit will cause poor quality. This adjustment should be held at minimum plate current (on meters M1I and M3I) at all times.

The capacity of the coupling condensers C5I and C6I should always be as given in Table VI (also see Table V, page 124).

Modulating Amplifier (V3D).

The modulating amplifier should be operated with the proper input as indicated by M2D, the reading of this meter being maintained, by means of C18D, at the value determined from the curve on pages 114 and 191.

Tuning of All Output Circuits.

In order that the load impedance for each amplifier be correct, it is necessary to have each output circuit adjusted to give minimum plate current.

TABLE VI—CAPACITY OF COUPLING CONDENSERS

Number of Tubes in Third Amplifier	*Total Number of Condensers in Use*	*Effective Coupling Capacity* MF
6	20	0.0015
4	24	0.0018
2	32	0.0024

The impedances are also dependent upon the resistances associated with the output circuits and in case a condition of bad quality is not cleared up by the above procedure it is suggested that the load resistances R8D, R5F, R6F, R1G and R2G be measured to see if they are of the proper value as given in the section on Apparatus Information.

Trouble that May Develop in the Audio Amplifier System.

Generally, faults that can occur in the audio frequency system that impair the quality of the radiated signal, will be evident from meter readings. In case any of the meter readings are abnormal, the cause should be found and remedied.

In case bad quality is thought to originate in the audio amplifier system and all meters read normal, test the secondary of T1D and the secondary shunt resistances R15.1D, R15.2D and R15.3D for open circuits.

Quartz Oscillator Temperature Control Circuit

Should trouble develop in the temperature control apparatus and the temperature rise to an excessive value, the operation of the "HEATER CON. RELAY" should be checked by throwing the "TEST SWITCH" to the "TEST POSITION". If the "RELAY CURRENT" decreases and the armature of the relay moves when this switch is thrown, the vacuum tube relay is functioning properly and the trouble is probably due to failure of the thermostat contacts to make contact due to the dust between them.

In this case, remove the thermometer, open the heater box and lift out the quartz oscillator as one unit. Clean the contact of the thermostat with carbon tetrachloride.

Should the temperature drop to a low value the trouble may be due to the "HEATER CON. RELAY" being out of adjustment or sticking, the vacuum tube may be burned out, or the heater circuit may be open. Trouble of this nature cannot be caused by failure of the thermostat.

Spare Parts

The following vacuum tubes, for use in the No. 7-A Radio Transmitter are furnished with the No. 107-A Radio Telephone Broadcasting Equipment of which the No. 7-A Radio Transmitter forms a part.

Vacuum Tubes for Service

2—No. 102-D Vacuum Tubes for AC Power Supply
2—No. 102-F Vacuum Tubes for DC Power Supply
5—No. 248-A Vacuum Tubes
8—No. 232-A Vacuum Tubes
6—No. 237-A Vacuum Tubes
3—No. 234-A Vacuum Tubes
3—No. 212-D Vacuum Tubes

Vacuum Tubes for Spares

2—No. 102-D Vacuum Tubes for AC Power Supply
2—No. 102-F Vacuum Tubes for DC Power Supply
5—No. 248-A Vacuum Tubes
8—No. 232-A Vacuum Tubes
6—No. 237-A Vacuum Tubes
3—No. 234-A Vacuum Tubes
3—No. 212-D Vacuum Tubes

The following spare parts are furnished as a part of the No. 7-A Radio Transmitter.

Hose Couplings and Washers

(Parts associated with No. 132-A and No. 133-A Vacuum Tube Sockets.)

12—KS-6431 Hose Couplings
12—KS-6432 Hose Couplings
50—¾-inch Hose Coupling Washers per detail 1, ESA-318250
50—1-inch Hose Coupling Washers per detail 2, ESA-318250
50—Gaskets per detail 3, ESL-310847
50—Gaskets per detail 4, ESL-310847

Rings and Wrap Lock Kit

(Parts associated with No. 132-A and No. 133-A Vacuum Tube Sockets.)

6—Rings per assembly detail 1, ESL-311047
6—Rings per assembly detail 1, ESA-316369
2—Clamping Rings per detail 1, ESL-312516
(—Mosler Metal Products Company, Mount Vernon, N. Y.
—Wrap Lock Kit

Motor Generator Brushes

1—Set Brushes for Motor Generator No. KS-5154
1—Set Brushes for Motor Generator No. KS-5155

Apparatus Information

FUSES

Designation	*Capacity, Amperes*	*Voltage*	*Manufacturer and Manufacturer's Number*
		No. D-85486 Power Panel Unit	
F1A	6	600	D & W No. 28087
F2A	9	600	D & W No. 28090
F3A	350	600	D & W No. 28122
F4A	80	600	D & W No. 28106
F5A	300	600	D & W No. 28120
F6A	3	600	D & W No. 28084
F7A	1	250	D & W No. 91001
F8A	3	250	D & W No. 91125
F9A	3	250	D & W No. 91125
F10A	9	250	D & W No. 91132
F11A	3	250	D & W No. 91125
F12A	1	600	D & W No. 28082
F13A	30	600	D & W No. 28096
F14A	30	600	D & W No. 28096
F15A	1	600	D & W No. 28082
F16A	6	600	D & W No. 28087
F17A	9	250	D & W No. 91132
F18A	3	250	D & W No. 91125
F19A	3	250	D & W No. 91125
F20A	3	250	D & W No. 91125
F21A	3	250	D & W No. 91125
F22A	5.1	...	G E Cutout—Fusible Link No. 167539
F23A	16.6	...	G E Cutout—Fusible Link No. 167539
		No. D-85487 Rectifier Unit	
F1B	3	600	D & W No. 28084
F2B	1	600	D & W No. 28082
F3B	6	600	D & W No. 28087
F4B	6	600	D & W No. 28087
F5B	6	600	D & W No. 28087
F6B	1	2,500	W E No. 2760
F7B	2	2,500	W E No. 2760
		No. D-85488 Rectifier Unit	
F1C	1	600	D & W No. 28082
F2C	9	600	D & W No. 28090
F3C	9	600	D & W No. 28090
F4C	9	600	D & W No. 28090
F5C	9	600	D & W No. 28090
F6C	9	600	D & W No. 28090
F7C	9	600	D & W No. 28090
		No. D-85489 Oscillator Modulator Unit	
F1D	3	600	D & W No. 28084
F2D	3	250	D & W No. 91125
F3D	3	250	D & W No. 91125
F4D	3	250	D & W No. 91125

Designation	*Capacity, Amperes*	*Voltage*	*Manufacturer and Manufacturer's Number*
		No. D-85491 Second Amplifier Tube Unit	
F1F	150	250	D & W No. 91162
F2F	3	250	D & W No. 91125
F3F	20	250	D & W No. 91136
F4F	15	250	D & W No. 91135
F5F	6	250	D & W No. 91128
		No. D-85493 Third Amplifier Tube Unit	
F1H	400	250	D & W No. 91172
		No. D-85495 Antenna Coupling Unit	
F1J	3	250	D & W No. 91125
		No. D-88169 Antenna Grounding Switch Control Panel	
F1N	10	250	D & W No. 91133
		Power Equipment	
F1P	30	250	D & W No. 91138
F2P	30	250	D & W No. 91138
F3P	1.8	...	G E Cutout—Fusible Link No. 167539
F4P	1.8	...	G E Cutout—Fusible Link No. 167539
F5P	1.8	...	G E Cutout—Fusible Link No. 167539

RESISTANCES

No. D-85486 Power Panel Unit

R1A—2 ohms variable plus 1 ohm fixed
R2A—650 ohms variable plus 250 ohms fixed
R3A—1,500 ohms
R4A—17,000 ohms
R5A—Weston External Resistor furnished with meter M2A
R6A—Weston External Resistor furnished
R7.11A—1.5 ohms
R7.12A—1.5 ohms
R7.13A—3.5 ohms
R7.14A—5 ohms
R7.15A—5 ohms
R7.16A—5 ohms
R7.17A—5 ohms
R7.18A—5 ohms
R7.19A—5 ohms
R7.110A—5 ohms
R7.111A—5 ohms
R7.112A—5 ohms
R7.113A—5 ohms
R7.114A—1.3 ohms
R7.115A—4.6 ohms
R7.116A—4.6 ohms
R7.2A—1.6 ohms
R7.31A—3.75 ohms
R7.32A—3.75 ohms
R7.33A—3.75 ohms
R7.34A—1.25 ohms
R7.35A—1.25 ohms
R8A—360 ohms
R9A—7 ohms

No. D-85487 Rectifier Unit

R1B—Weston External Resistor furnished with meter M4B
R2B—300 ohms
R3B—Weston External Resistor furnished with meter M5B
R4B—10 ohms
R5B—500 ohms variable

No. D-85488 Rectifier Unit

R1C—0.5 ohm
R2C—Weston External Resistor furnished with meter M8C
R3C—30 ohms variable
R4C—30 ohms variable
R5C—30 ohms variable
R6C—30 ohms variable
R7C—30 ohms variable
R8C—30 ohms variable

No. D-85489 Oscillator Modulator Unit

R1D—5,000 ohms
R2D—3.37 ohms
R3.1D—100 ohms
R3.2D—100 ohms
R4.1D—5,000 ohms
R4.2D—5,000 ohms
R5D—5,000 ohms
R6D—3.37 ohms
R7D—3.37 ohms
R8.1D—44 ohms
R8.2D—44 ohms
R9.1D—150 ohms
R9.2D—150 ohms
R9.3D—150 ohms
R9.4D—150 ohms
R9.5D—270 ohms
R9.6D—500 ohms
R10.1D—100 ohms
R10.2D—100 ohms
R11D—5,000 ohms
R12D—950 ohms
R13D—27,240 ohms
R14D—27,240 ohms
R15.1D—100,000 ohms
R15.2D—100,000 ohms
R15.3D—100,000 ohms
R16D—3.37 ohms
R17D—9,600 ohms
R18D—5,400 ohms
R19D—48,000 ohms
R20.1D—6,000 ohms
R20.2D—6,000 ohms
R21D—1.03 ohms
R22.1D—100 ohms
R22.2D—100 ohms
R23D—1,500 ohms
R24.1D—100 ohms
R24.2D—100 ohms
R25D—1,500 ohms
R26.1D—10,000 ohms
R26.2D—10,000 ohms
R27.1D—44 ohms
R27.2D—44 ohms
R28D—88 ohms
R29D—88 ohms
R30.1D—100 ohms
R30.2D—100 ohms
R31D—950 ohms
R32D—General Electric Type "T2" 18-volt, 0.11-ampere candelabra base tubular bulb lamp
R33D—General Electric Type "T2" 18-volt, 0.11-ampere candelabra base tubular bulb lamp.
R34D—100,000 ohms
R35D—100,000 ohms
R36D—10,000 ohms
R37D—10,000 ohms
R38D—20,000 ohms
R39D—20,000 ohms
R42D—10,000-ohm potentiometer
R43D—260 ohms
R44D—10,000-ohm potentiometer
R45D—500 ohms

No. D-85490 First Power Amplifier Unit

R1E—1.05 ohms
R2E—1.05 ohms
R3.1E—100 ohms
R3.2E—100 ohms
R4E—360 ohms
R5.1E—500,000 ohms
R5.2E—500,000 ohms

No. D-85491 Second Power Amplifier Tube Unit

R1F—400 ohms
R2F—400 ohms
R3F—20 ohms
R4F—20 ohms
R5F—890 ohms
R6F—890 ohms
R7F—200 ohms
R8F—50 ohms
R9F—50 ohms

No. D-85492 Second Amplifier Tuning Unit

R1G—150 ohms
R2G—150 ohms
R3G—500,000 ohms

No. D-85493 Third Power Amplifier Tube Unit

R1H—400 ohms
R2H—400 ohms
R3H—400 ohms
R4H—400 ohms
R5H—400 ohms
R6H—400 ohms
R7H—2 ohms
R8H—2 ohms
R9H—200 ohms

No. D-85494 Third Power Amplifier Tuning Unit

R1I—440 ohms
R2I—1,000 ohms
R3I—440 ohms
R4I— 40 ohms
R5I—123 ohms
R6I—100 ohms
R7I—3.17 ohms
R8I—2 megohms
R9I—2 megohms
R10I—Meter Compensating Resistance, 5.5 ohms
R11I—Resistance furnished with Westinghouse Position Indicator 11I
R12I—Same as R11I
R13I—Same as R11I
R14I—Same as R11I

No. D-86650 Artificial Antenna

R1K—See curve on pages 109 and 189
R2K—See curve on pages 109 and 189

No. D-88169 Antenna Switch Control Box

R1N—Bryant No. 618 type T-7, 125-volt candelabra base tubular bulb
R2N—1,900 ohms
R3N—1,900 ohms
R4N—Bryant No. 618 type T-7, 125-volt candelabra base tubular bulb

Power Equipment

R1P—Weston External Resistor furnished with M7C

Vacuum Tubes

No. D-85487 Rectifier Unit

V1B—No. 234-A Vacuum Tube
V2B—No. 234-A Vacuum Tube
V3B—No. 234-A Vacuum Tube

No. D-85488 Rectifier Unit

V1C—No. 237-A Vacuum Tube
V2C—No. 237-A Vacuum Tube
V3C—No. 237-A Vacuum Tube
V4C—No. 237-A Vacuum Tube
V5C—No. 237-A Vacuum Tube
V6C—No. 237-A Vacuum Tube

No. D-85489 Oscillator Modulator Unit

V1D—No. 248-A Vacuum Tube
V2D—No. 248-A Vacuum Tube
V3D—No. 248-A Vacuum Tube
V4D—No. 248-A Vacuum Tube
V5D—No. 212-D Vacuum Tube
V6D—No. 102-D Vacuum Tube
V7D—No. 102-D Vacuum Tube

No. D-85490 First Power Amplifier Unit

V1E—No. 212-D Vacuum Tube
V2E—No. 212-D Vacuum Tube

No. D-85491 Second Power Amplifier Tube Unit

V1F—No. 232-A Vacuum Tube
V2F—No. 232-A Vacuum Tube

No. D-85493 Third Power Amplifier Tube Unit

V1H—No. 232-A Vacuum Tube
V2H—No. 232-A Vacuum Tube
V3H—No. 232-A Vacuum Tube
V4H—No. 232-A Vacuum Tube
V5H—No. 232-A Vacuum Tube
V6H—No. 232-A Vacuum Tube

No. D-85494 Third Power Amplifier Tuning Unit

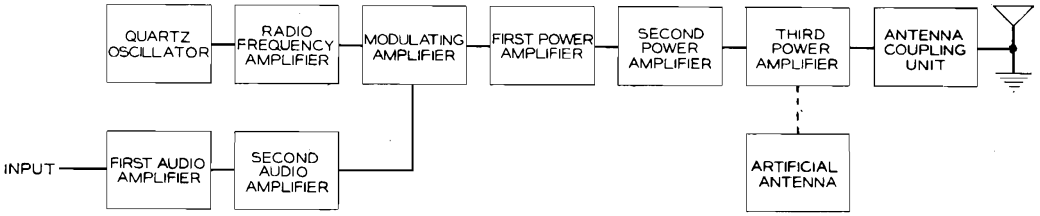
V1I—No. 248-A Vacuum Tube

Engineering Service

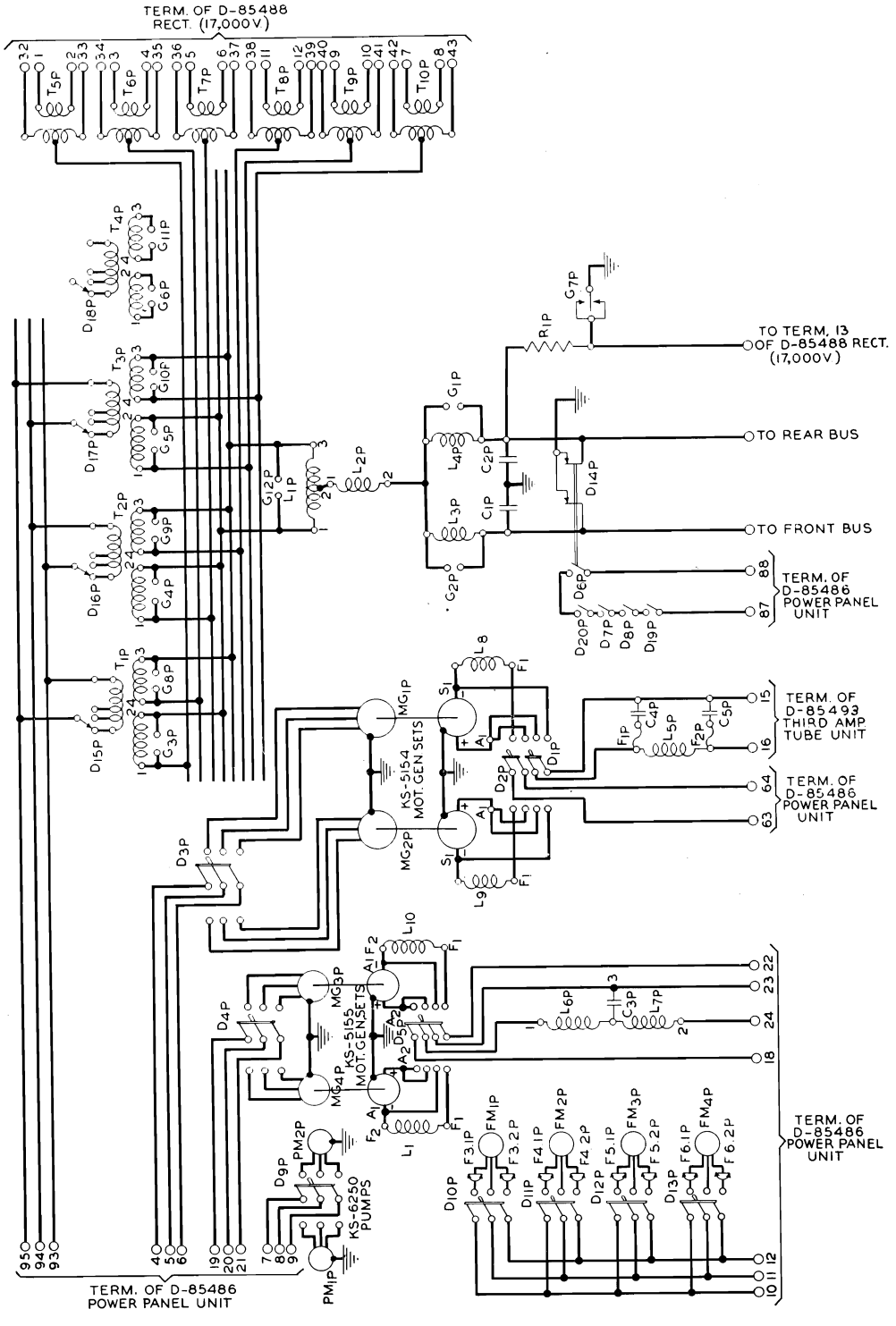
If the purchaser of this equipment desires engineering services, the matter should be referred to the nearest Branch House of the Graybar Electric Company, and authorization for such service placed with them. In Canada, this service may be obtained through the Northern Electric Company, Limited, and in other foreign countries through the International Standard Electric Corporation.

INSTRUCTION BULLETIN No. 411

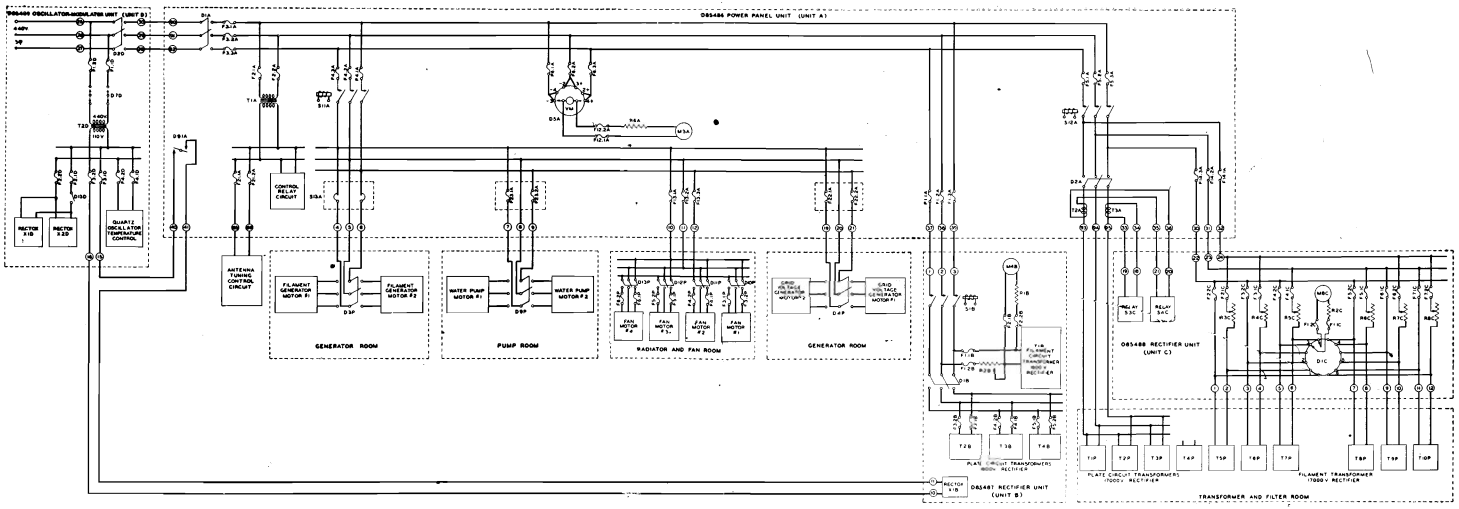
SCHEMATIC AND WIRING DIAGRAMS AND CHARTS



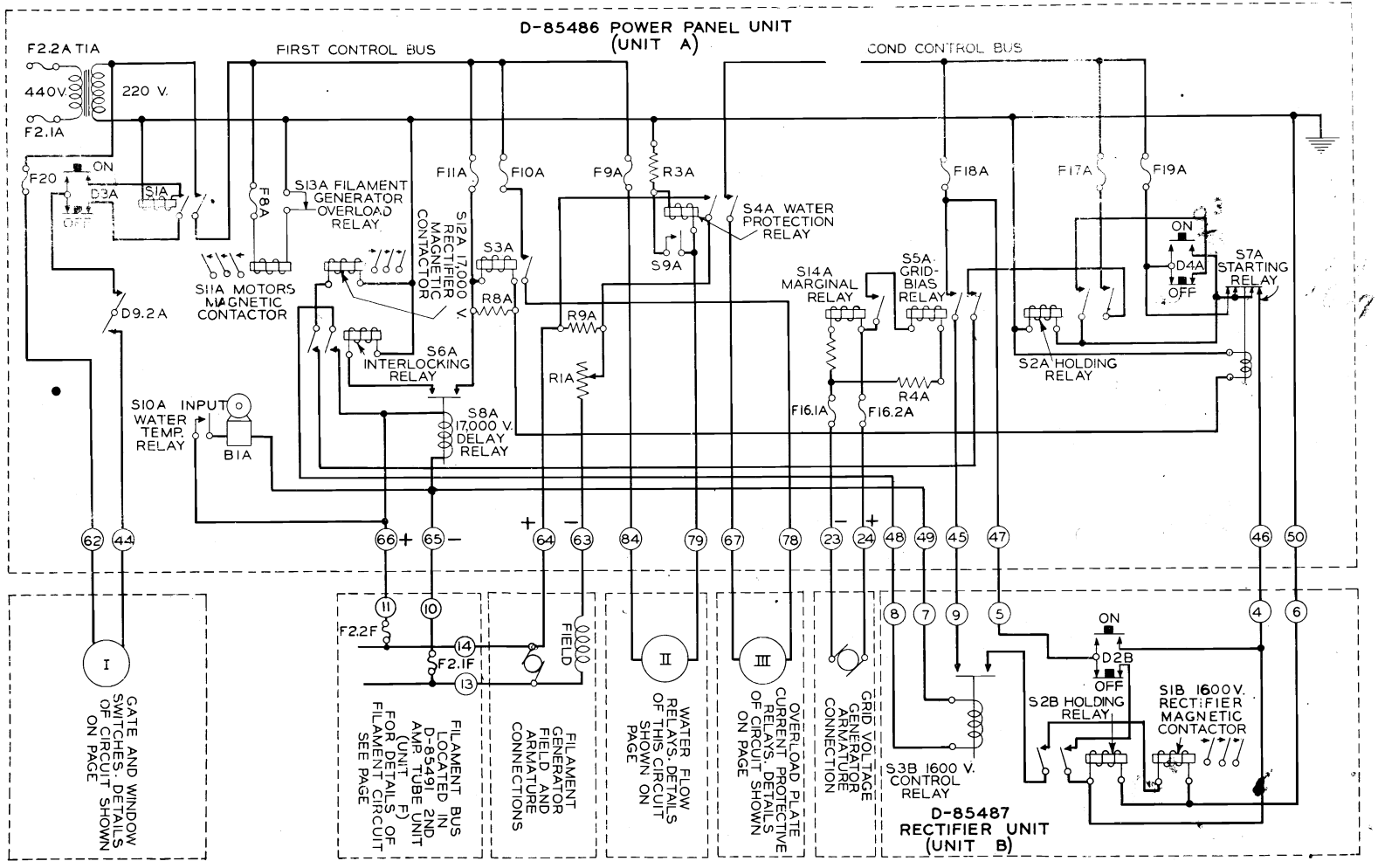
Block Schematic



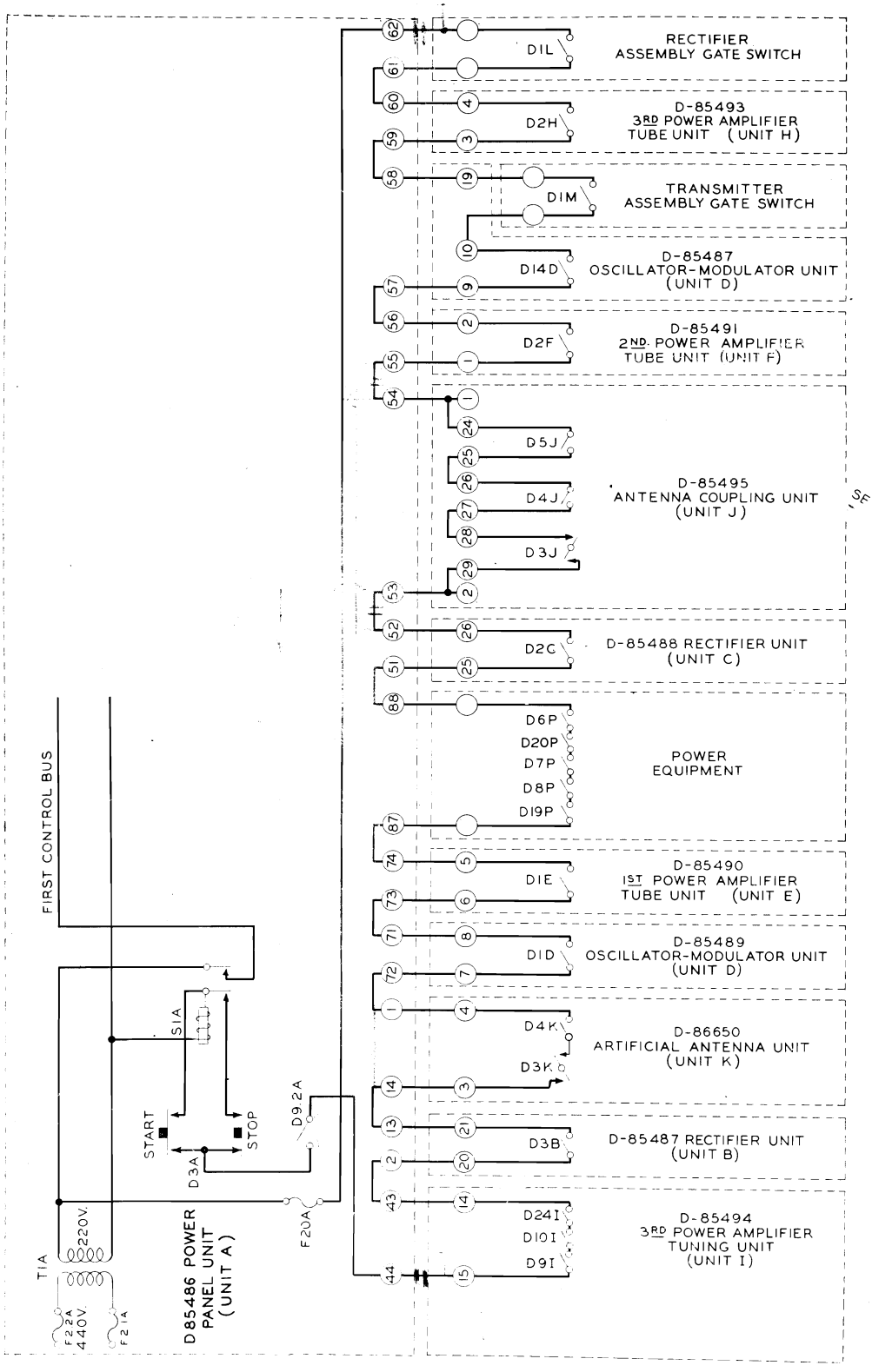
Schematic of Power Apparatus

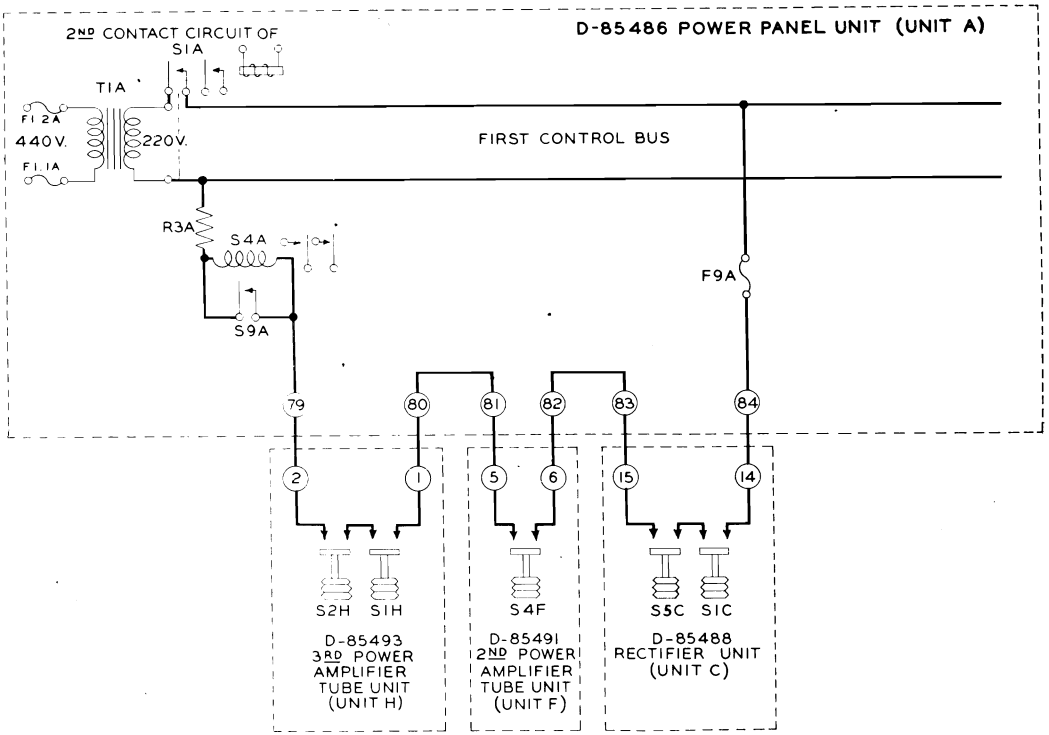


Distribution of Primary Power (*See also large diagram in envelope*)

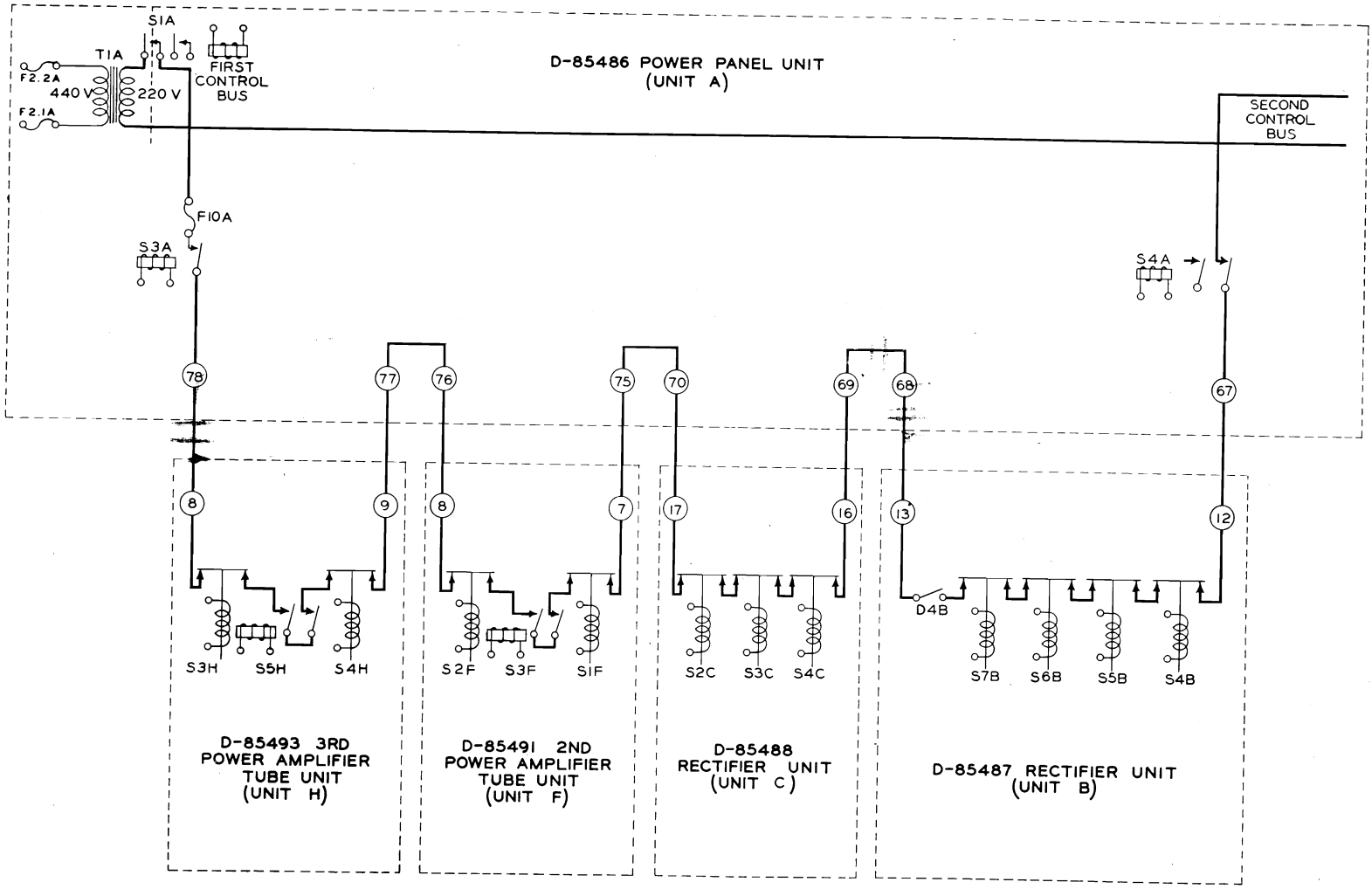


Power Control Circuit

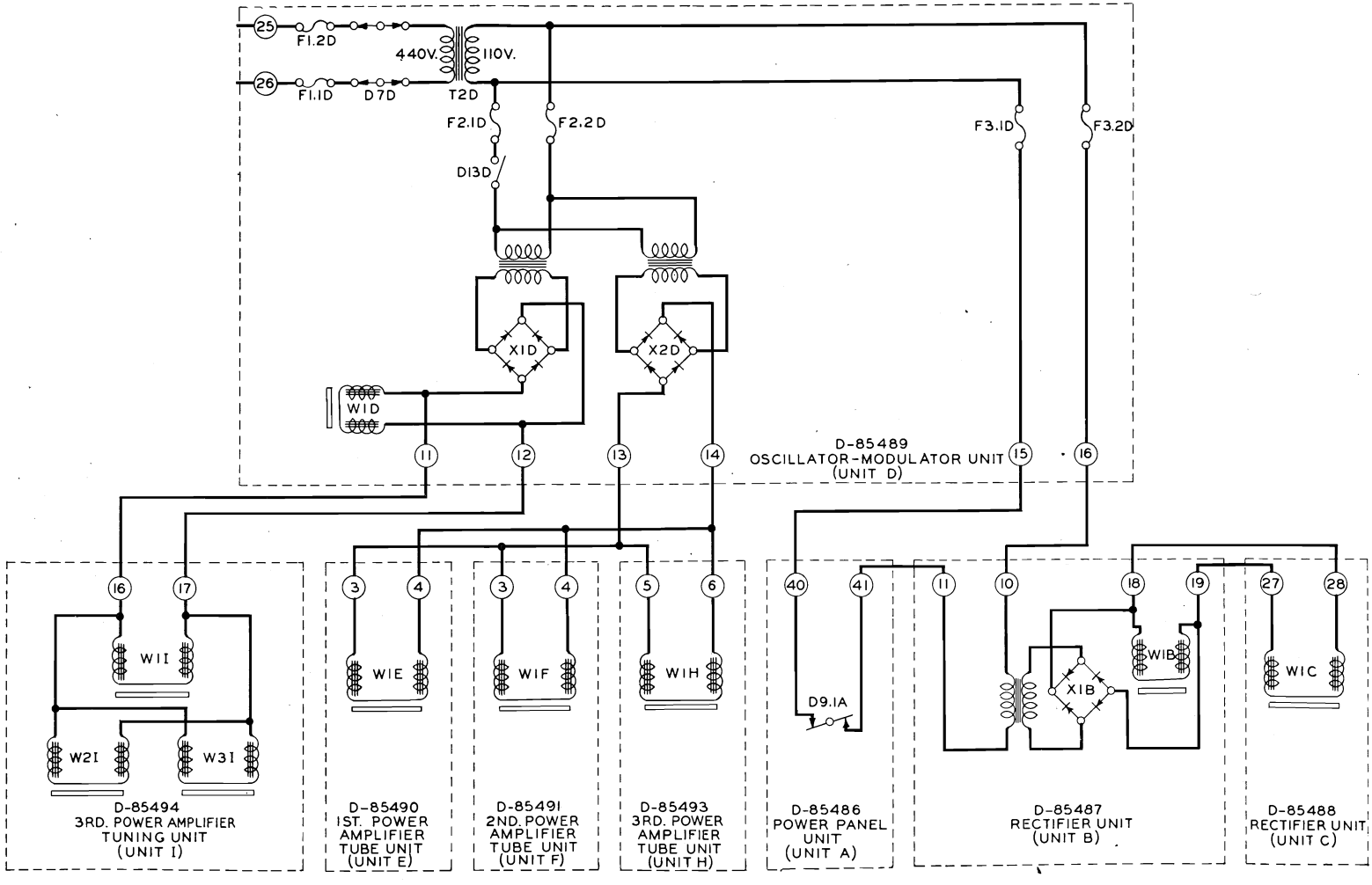

RECTIFIER ASSEMBLY GATE SWITCH
D1L
D-85493 3RD POWER AMPLIFIER TUBE UNIT (UNIT H)
D2H
TRANSMITTER ASSEMBLY GATE SWITCH
D1M
D-85487 OSCILLATOR-MODULATOR UNIT (UNIT D)
D14D
D-85491 2ND. POWER AMPLIFIER TUBE UNIT (UNIT F)
D2F
D-85495 ANTENNA COUPLING UNIT (UNIT J)
D5J
D4J
D3J
D-85488 RECTIFIER UNIT (UNIT C)
D2C
POWER EQUIPMENT
D6P
D20P
D7P
D8P
D19P
D-85490 IST POWER AMPLIFIER TUBE UNIT (UNIT E)
D1E
D-85489 OSCILLATOR-MODULATOR UNIT (UNIT D)
D1D
D-86650 ARTIFICIAL ANTENNA UNIT (UNIT K)
D4K
D3K
D-85487 RECTIFIER UNIT (UNIT B)
D3B
D-85494 3RD POWER AMPLIFIER TUNING UNIT (UNIT I)
D24I
D10I
D9I
FIRST CONTROL BUS
S1A
START
STOP
D3A
D9.2A
F20A
T1A
220V.
440V.
F2.2A
F2.1A
D85486 POWER PANEL UNIT (UNIT A)



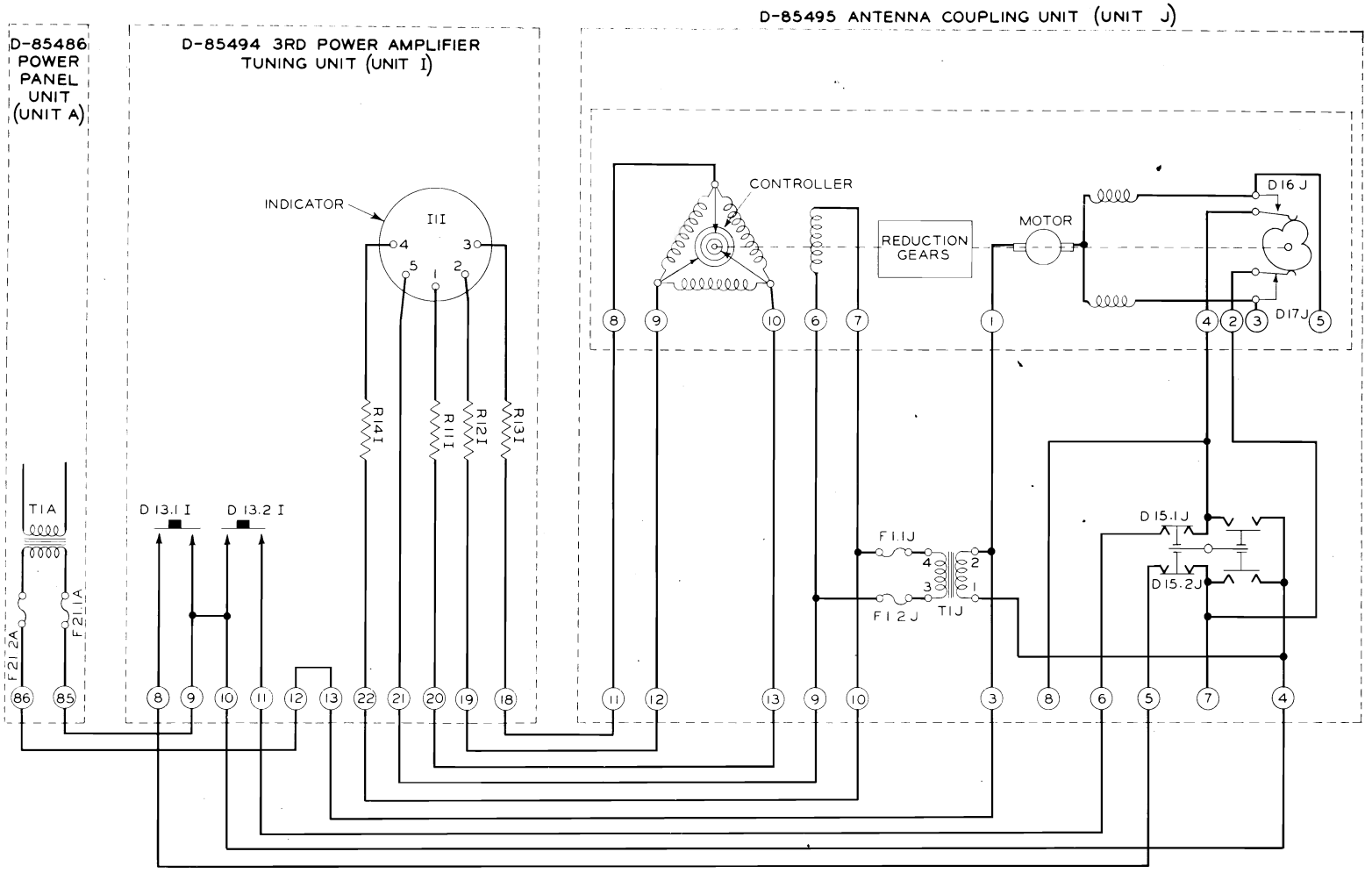
Water Flow Protection Control Circuit



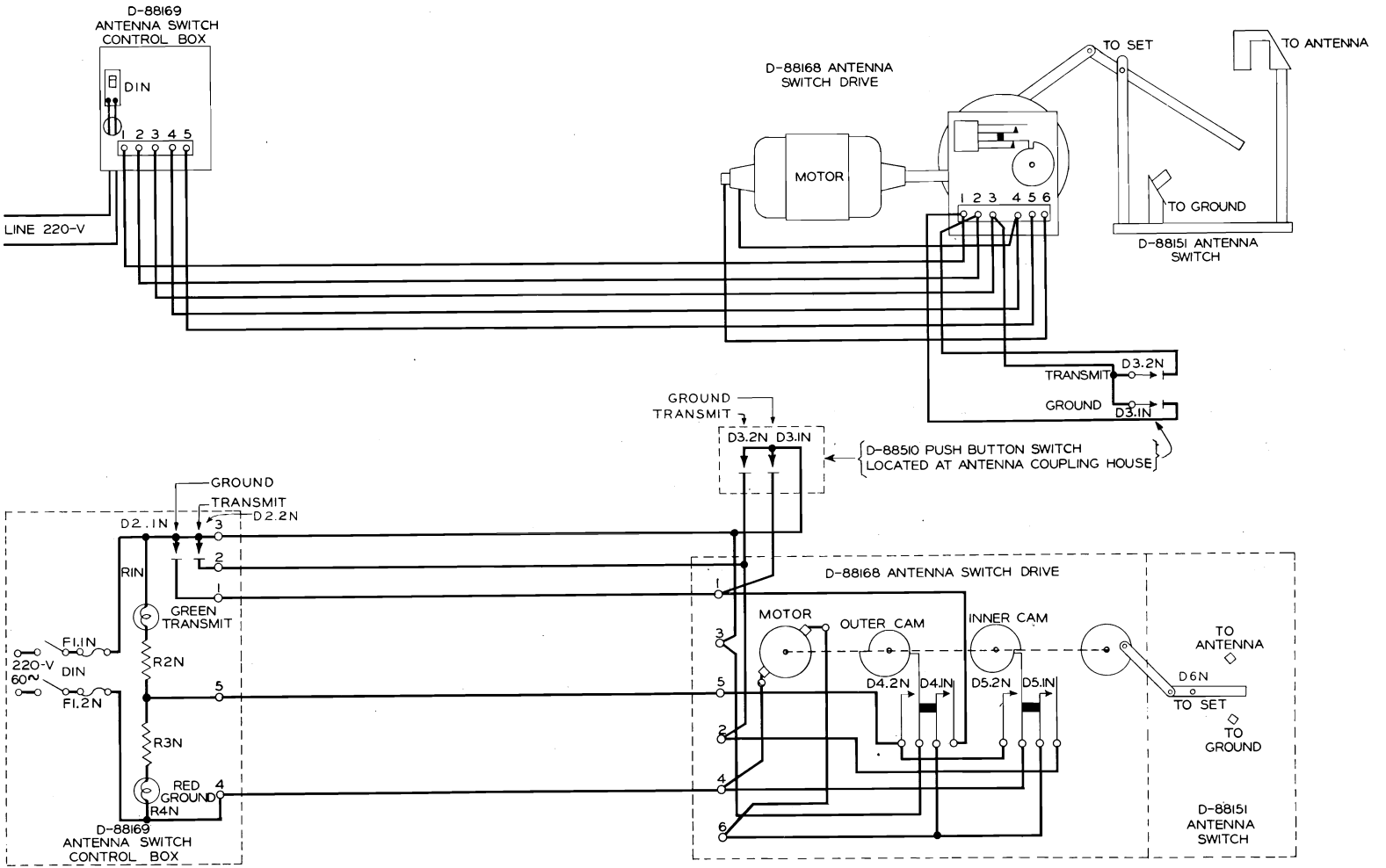
Tube Protection Control Circuit



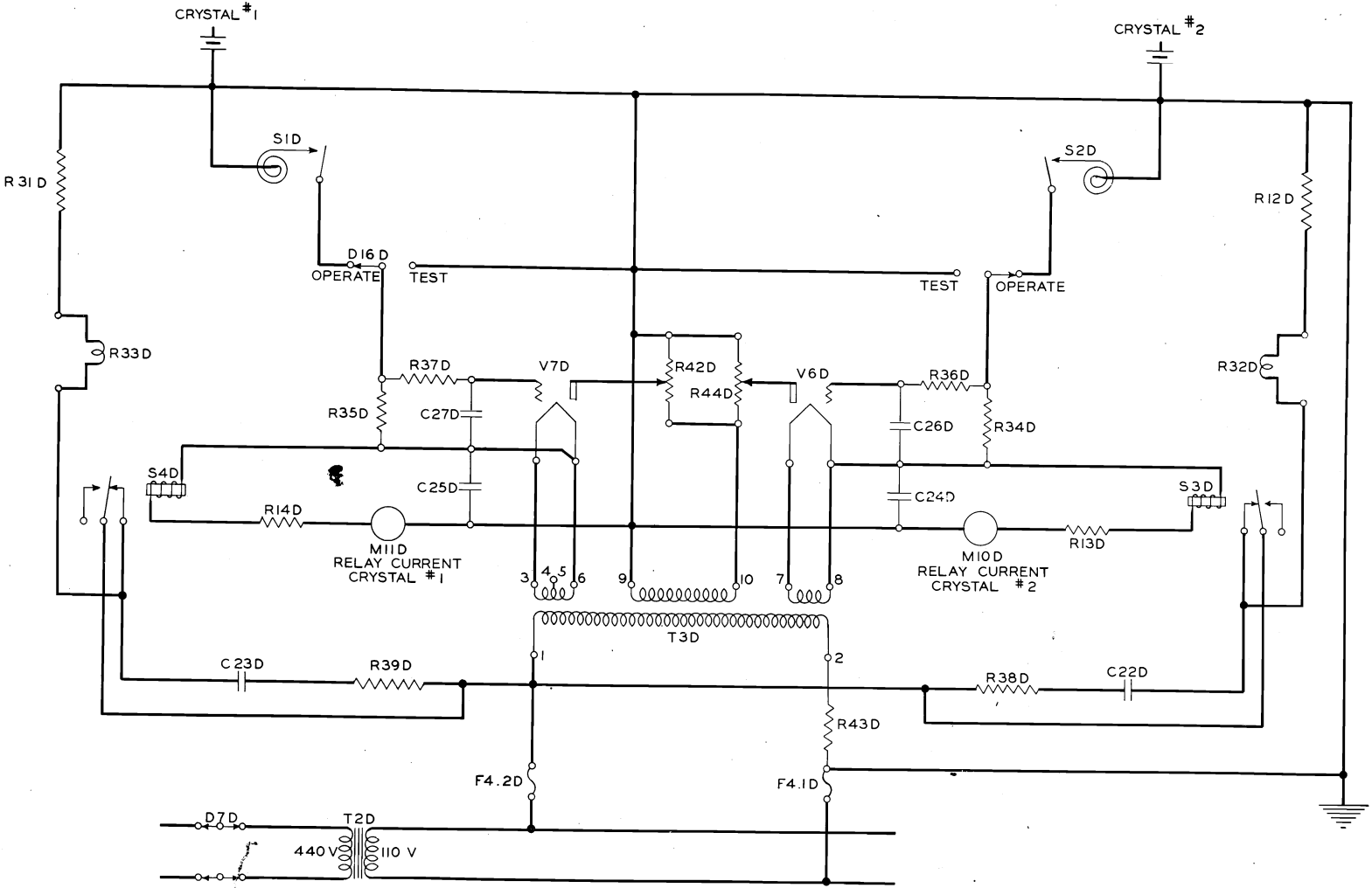
Door and Window Switch Control Circuit



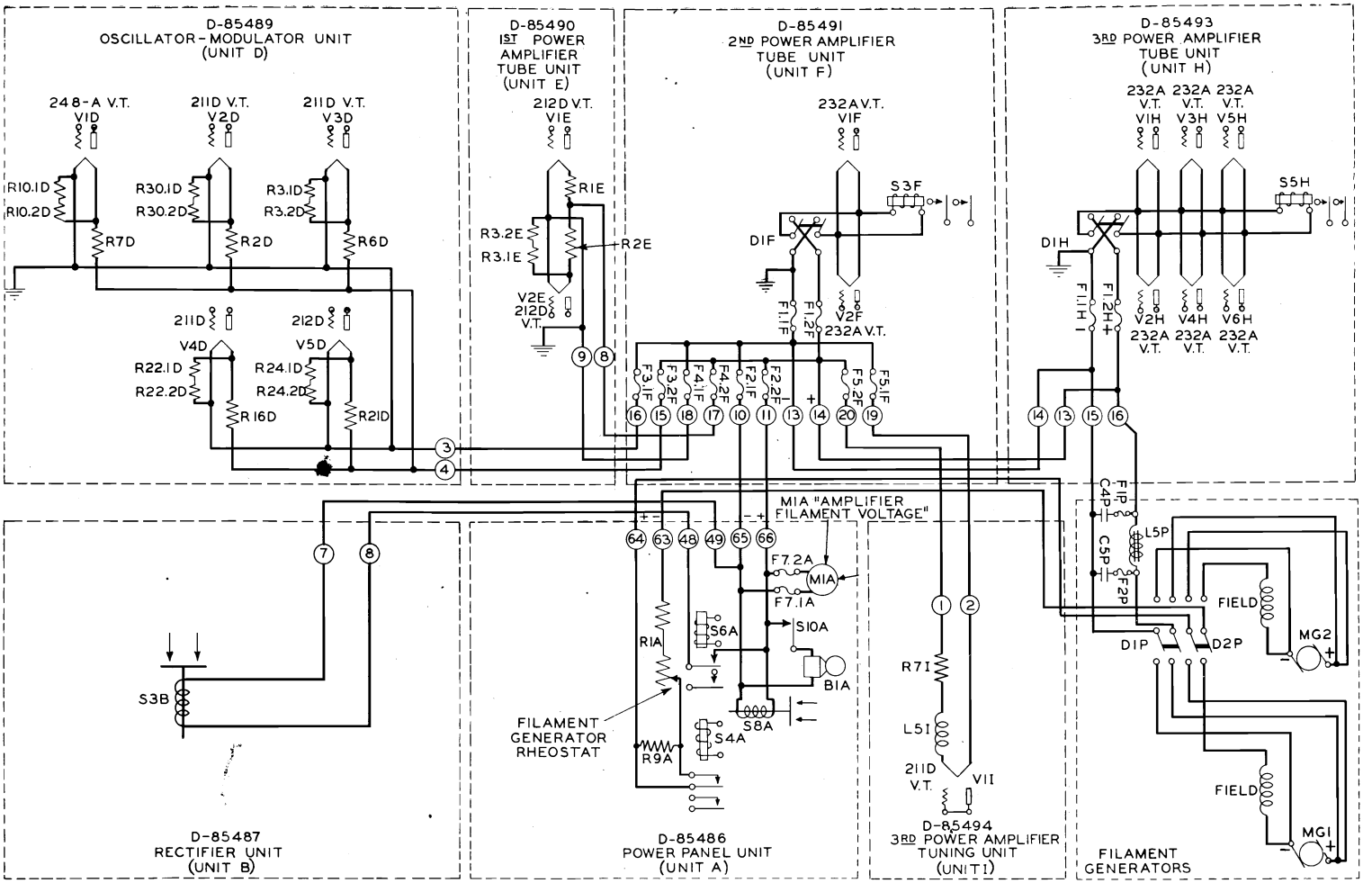
Antenna Tuning Control and Indicator Circuit



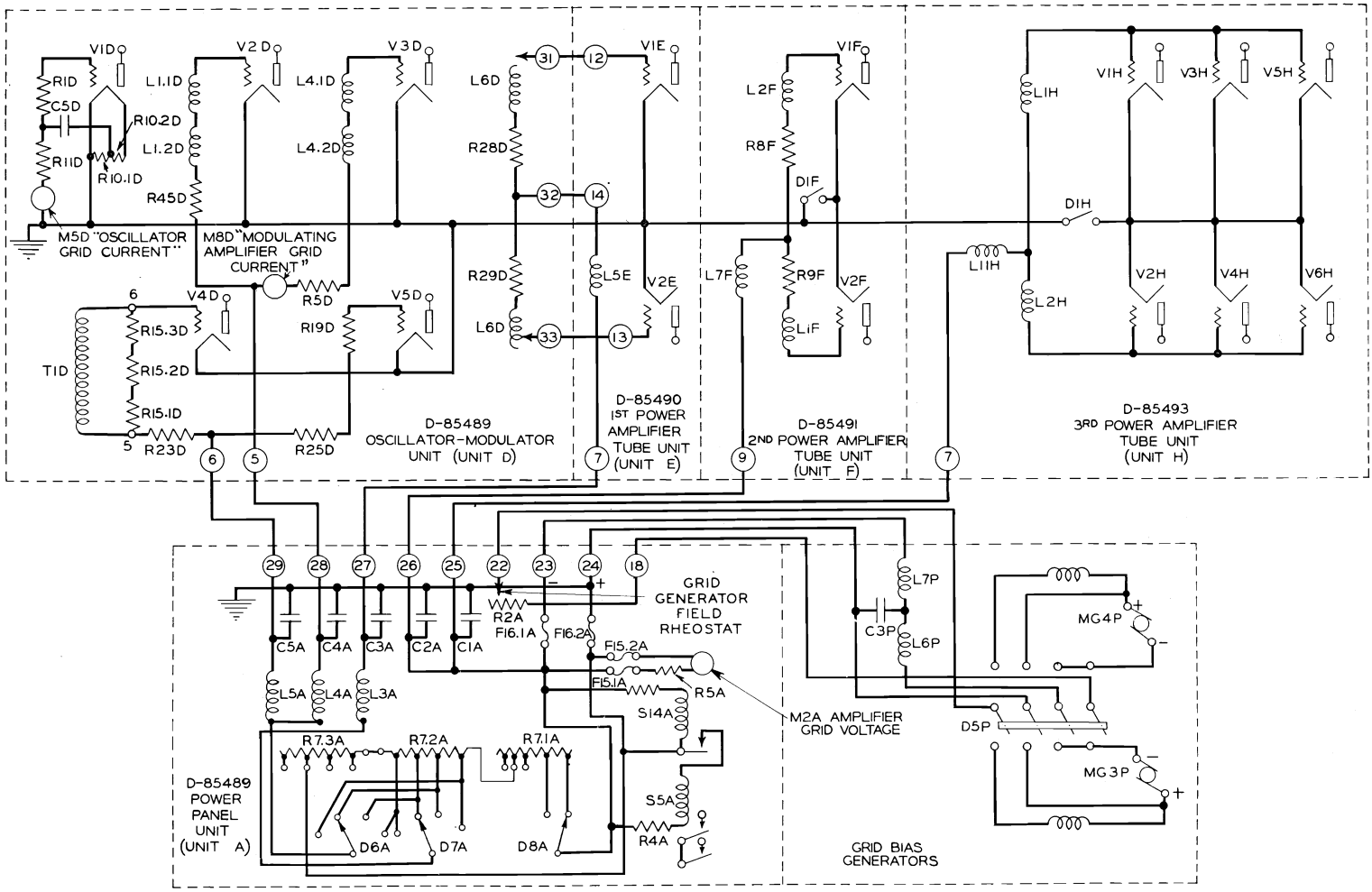
Wiring Diagram and Schematic of No. D-88357 Antenna Switching System



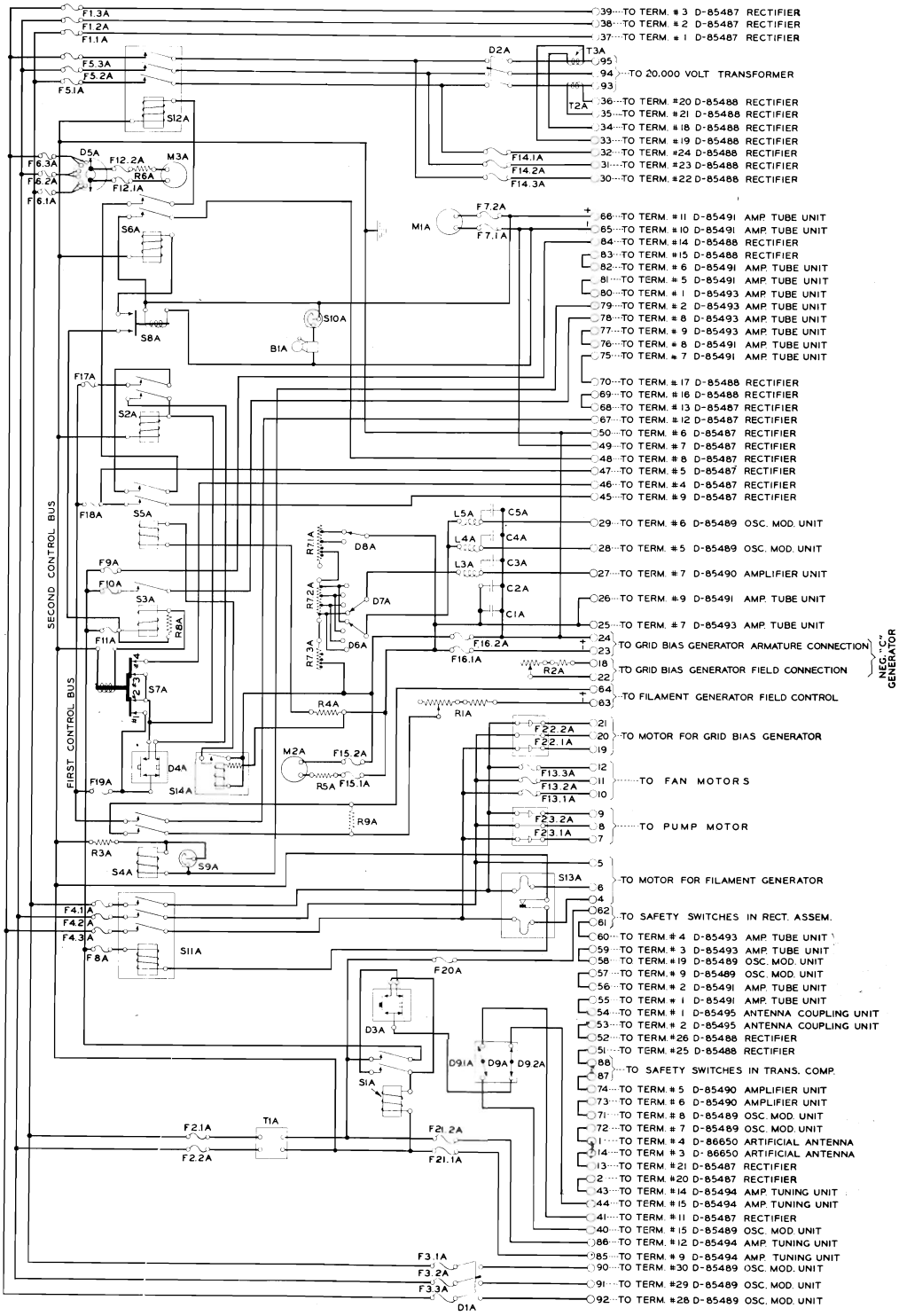
Temperature Control Circuit



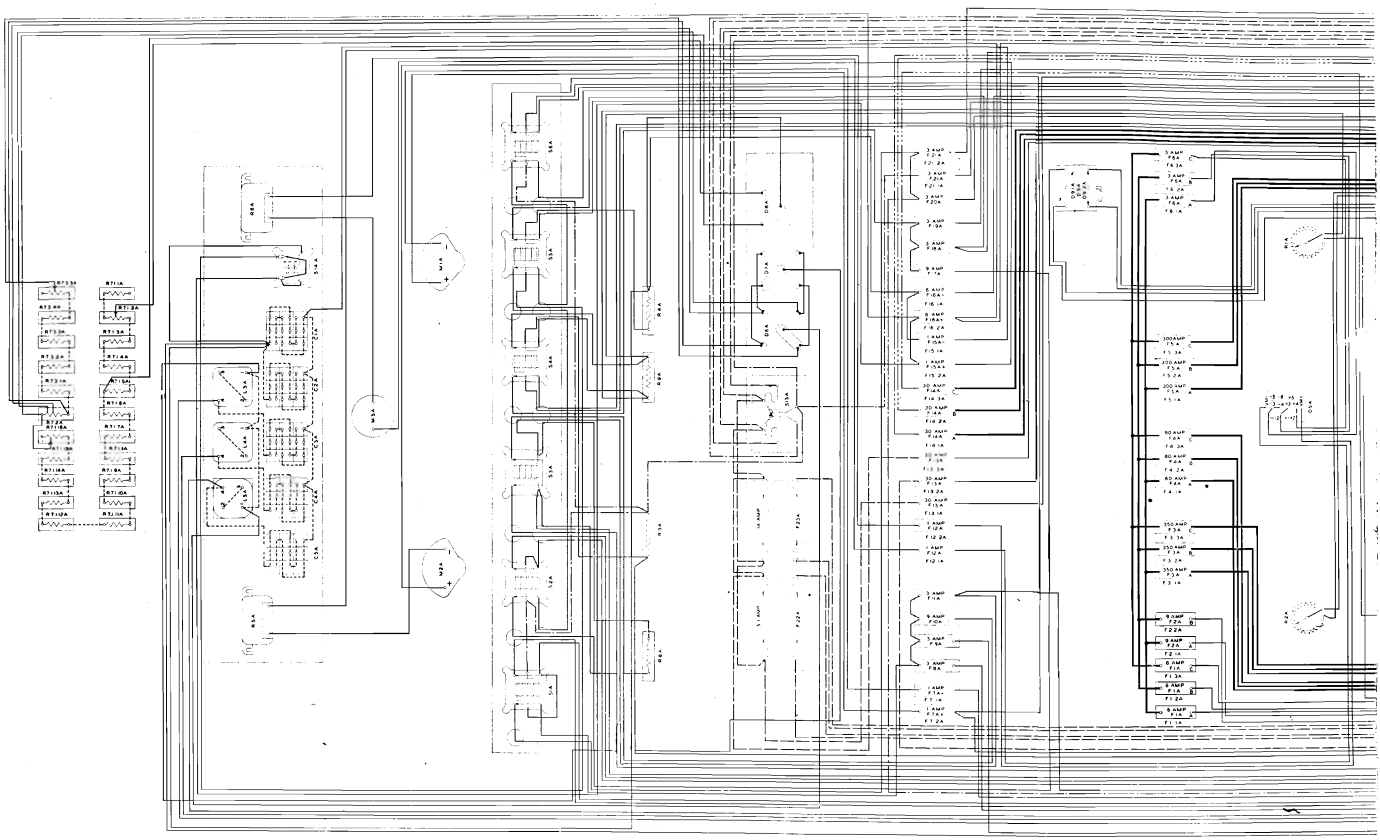
Filament Circuit



Grid Bias Circuit



Schematic of No. D-85486 Power Panel Unit
(See also large diagram in envelope)



Wiring Diagram of No. D-85486 Power Panel Unit
(See also large diagram in envelope)

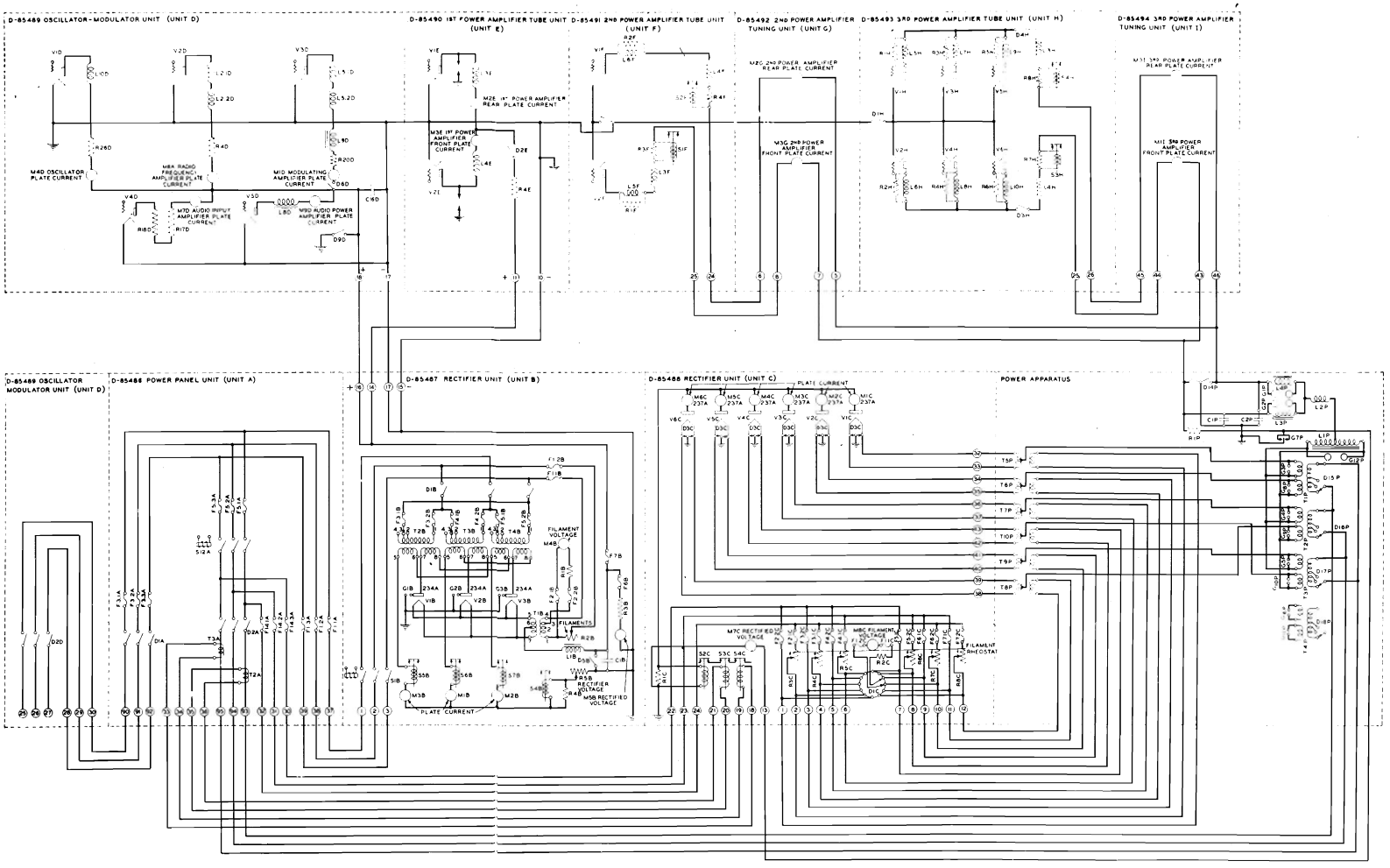
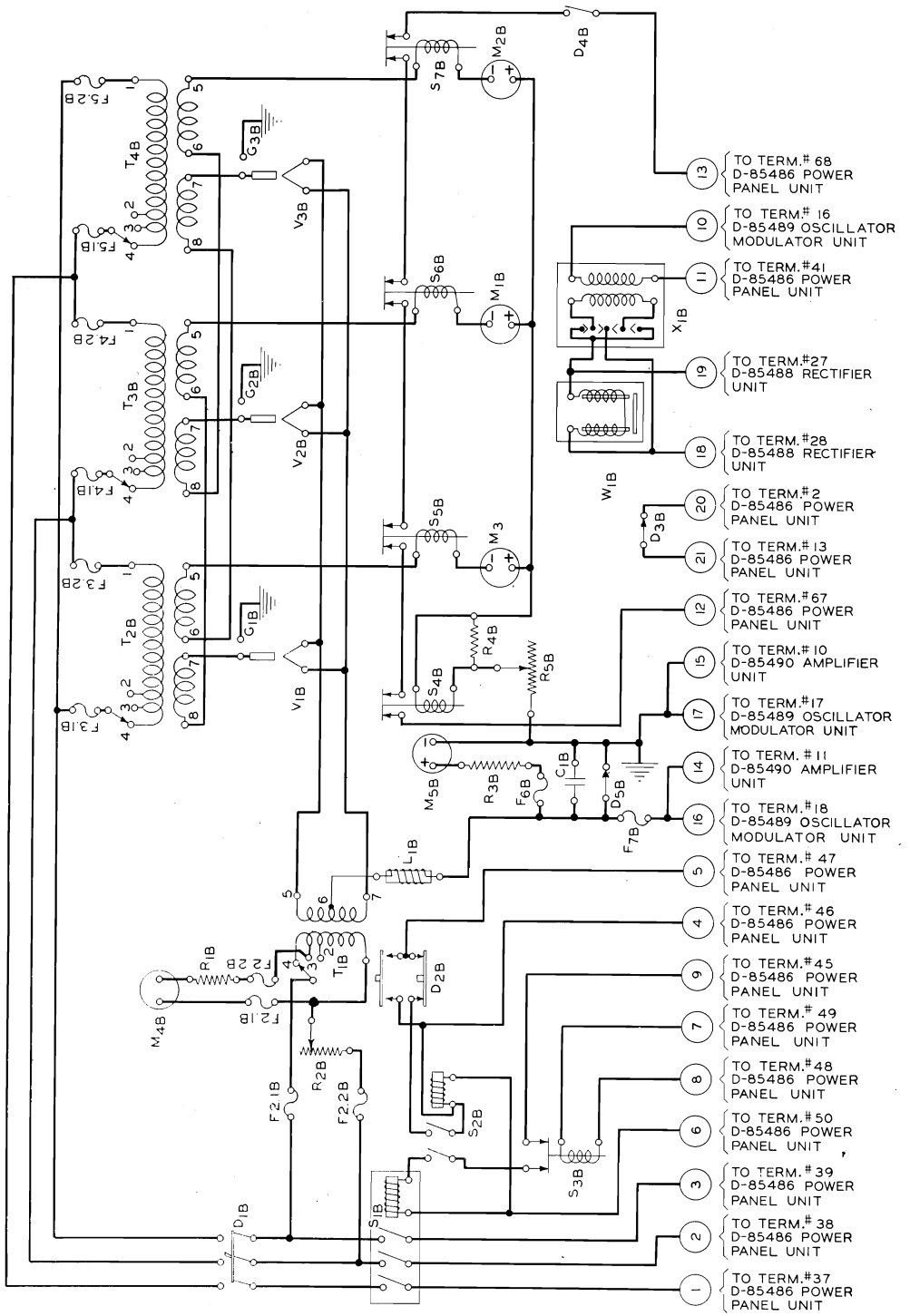
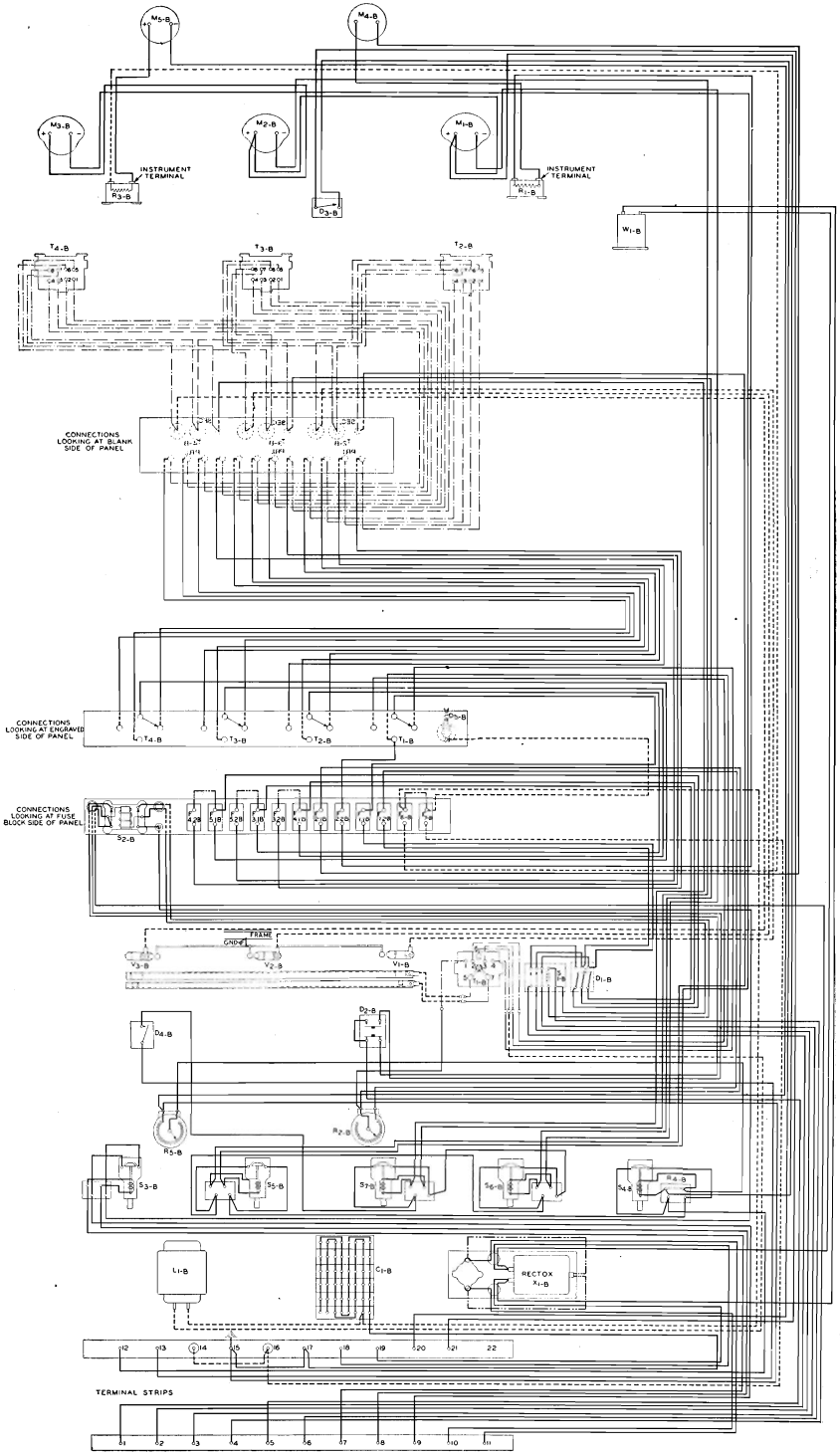


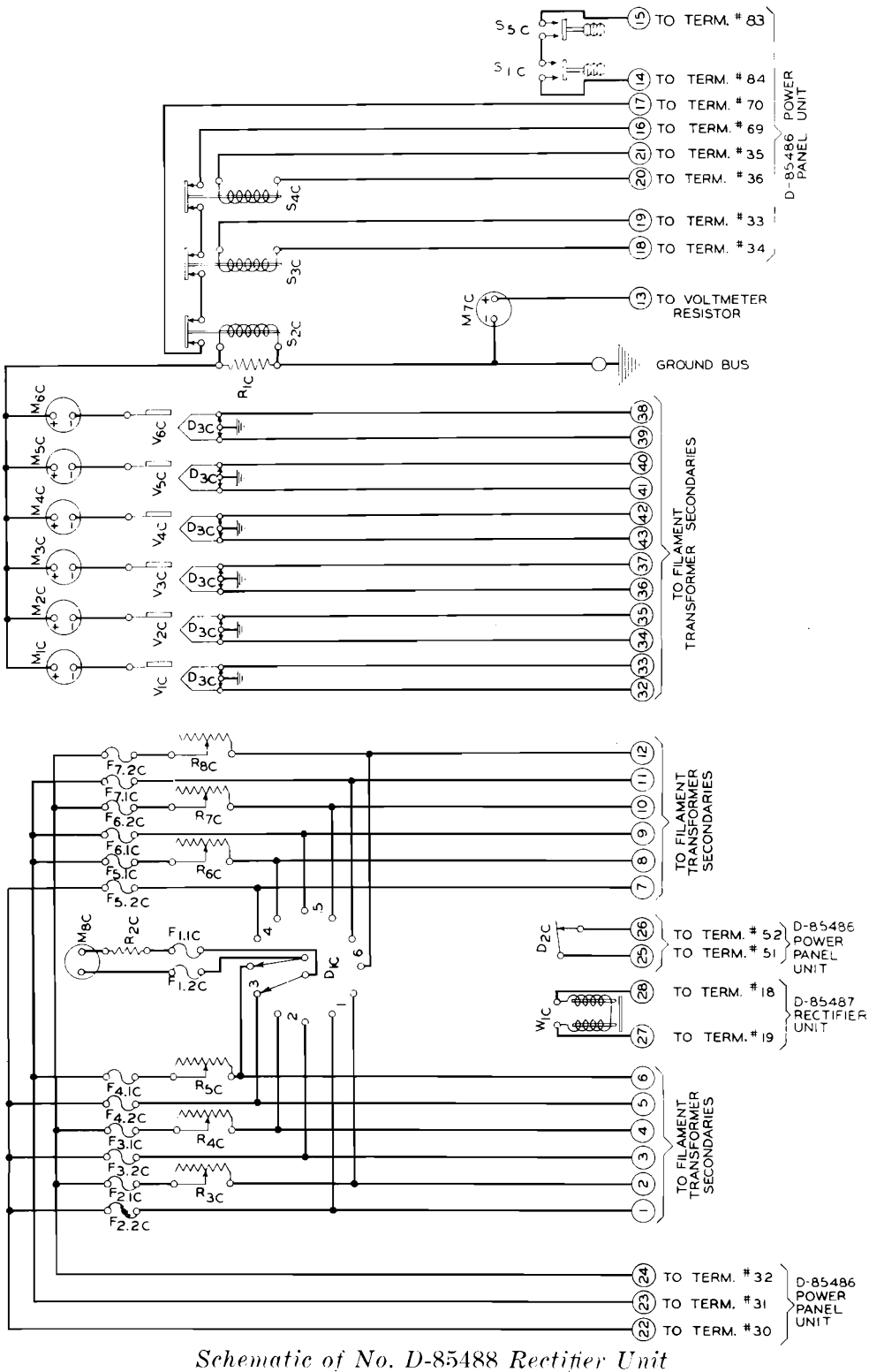
Plate Voltage Circuits (See also large diagram in envelope)



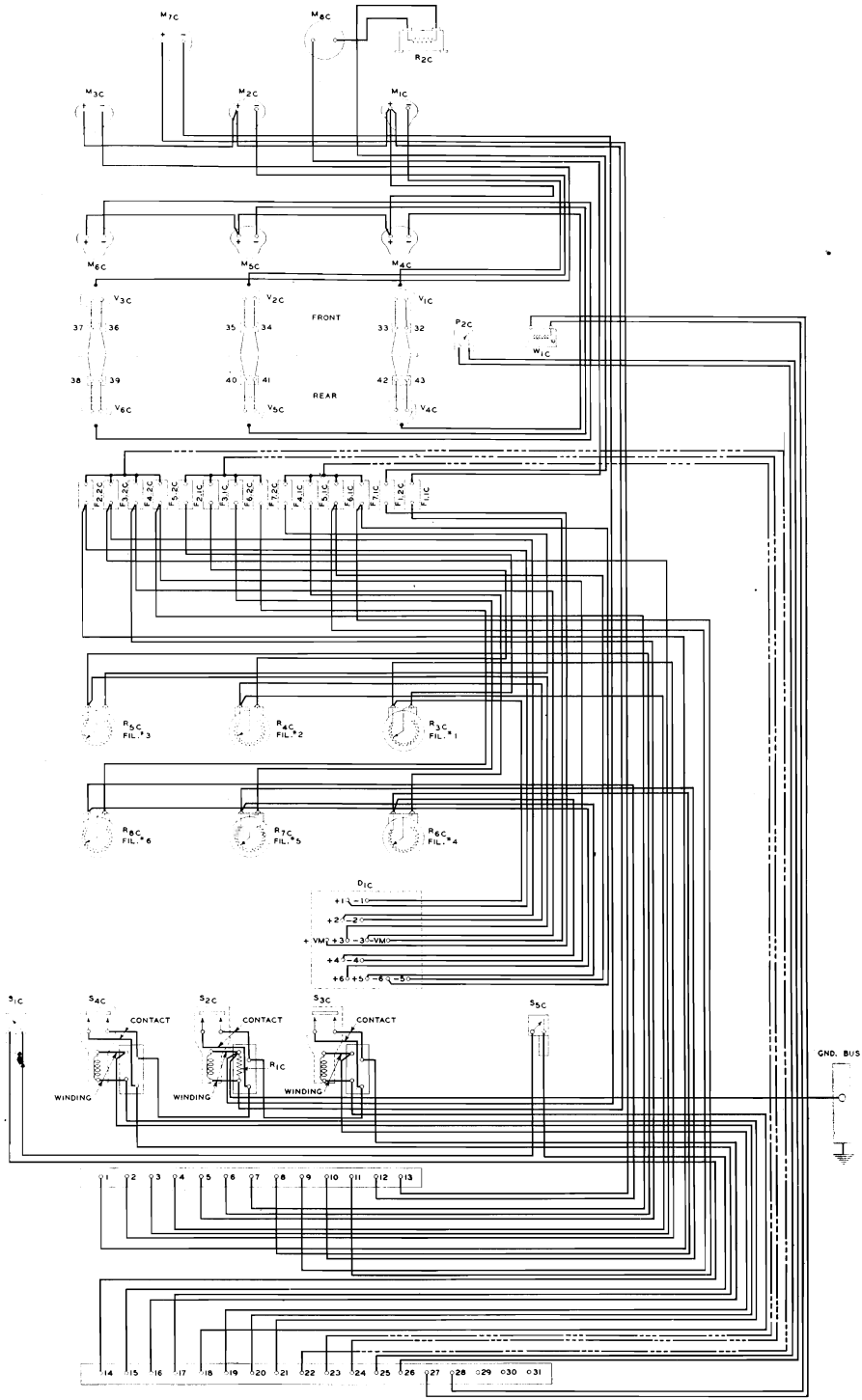
Schematic of No. D-85487 Rectifier Unit



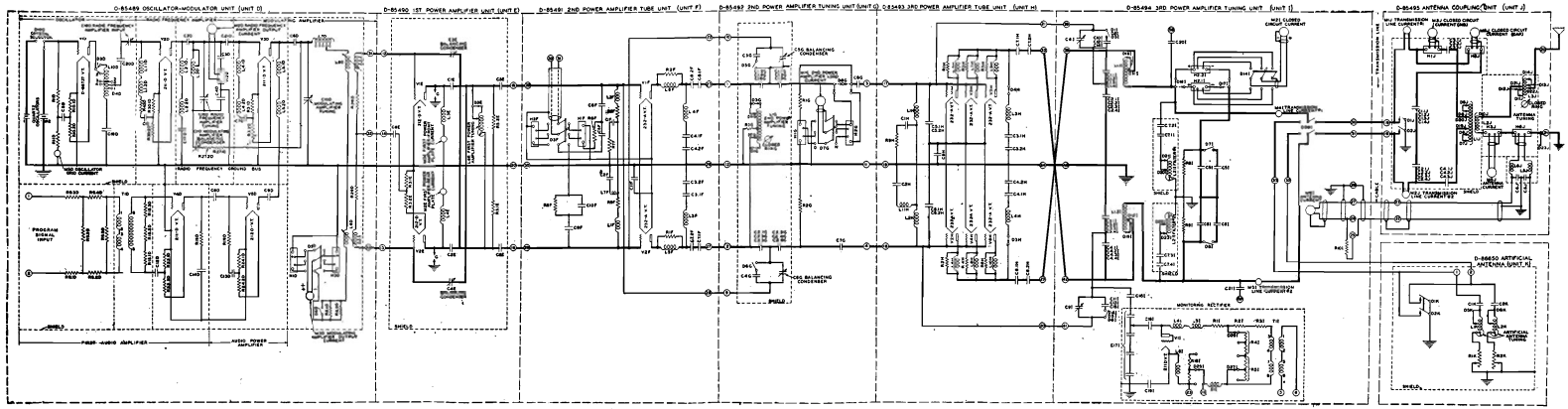
Wiring Diagram of No. D-85487 Rectifier Unit
(See also large diagram in envelope)



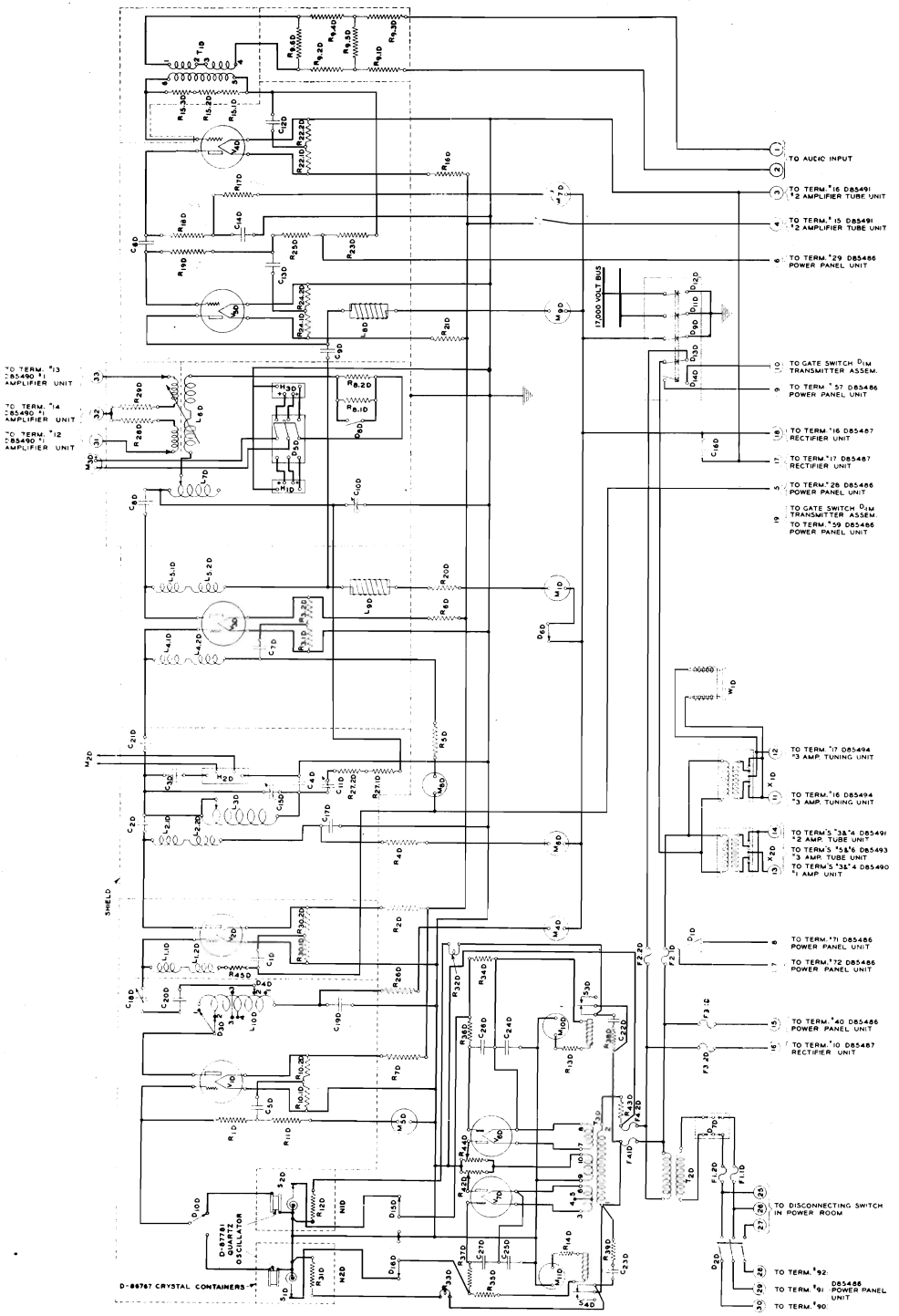
Schematic of No. D-85488 Rectifier Unit



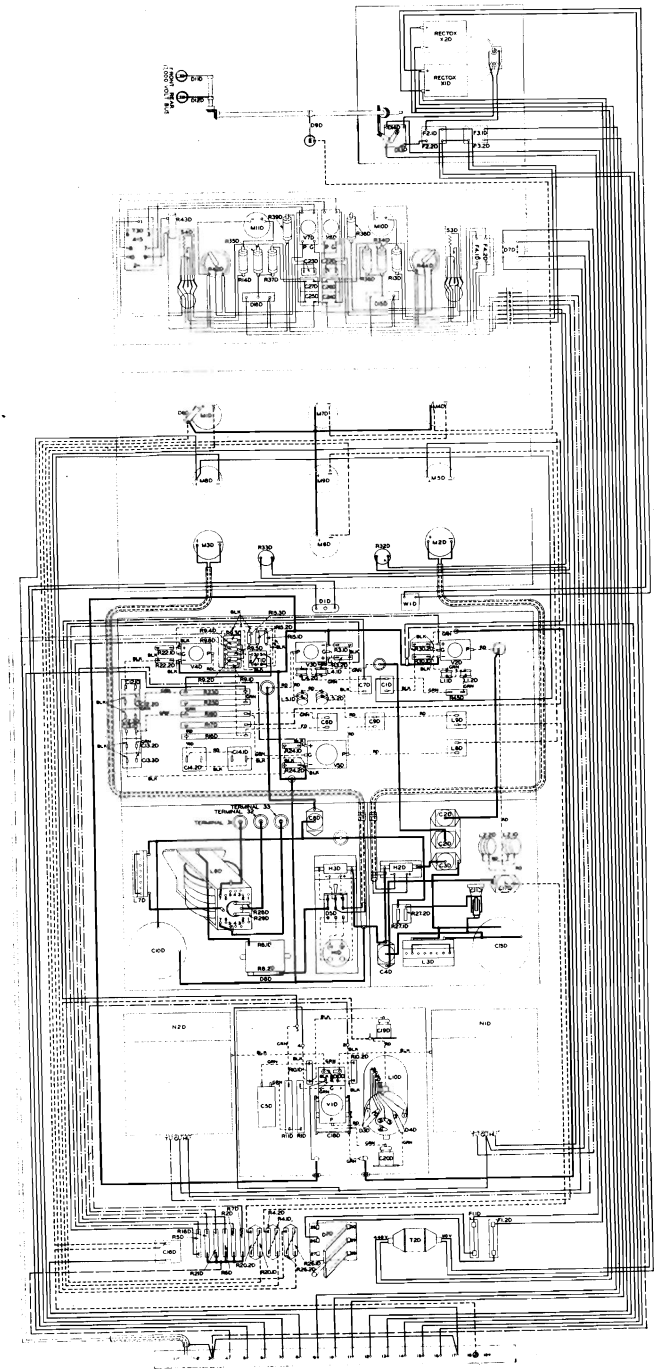
Wiring Diagram of No. D-85488 Rectifier Unit
(See also large diagram in envelope)



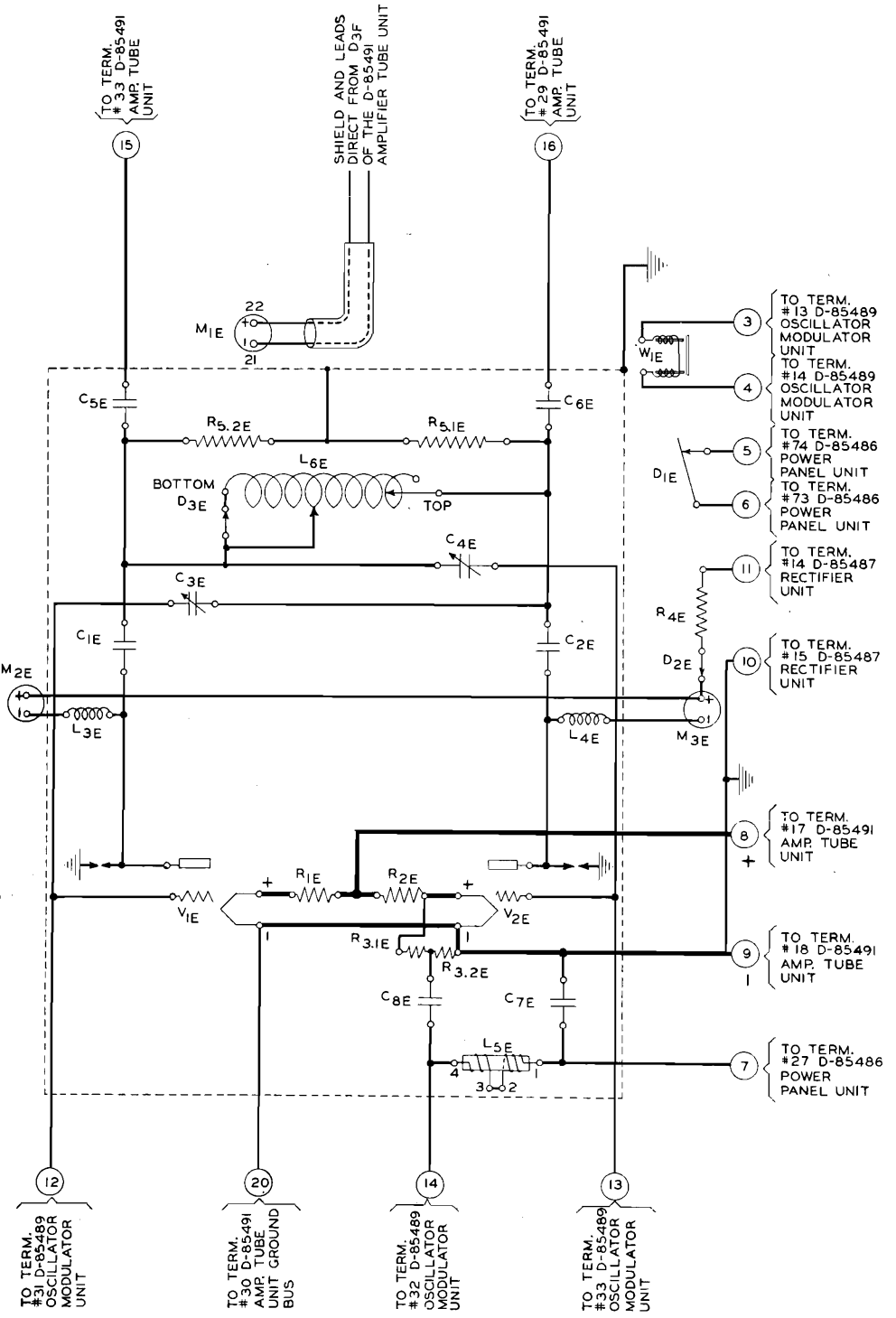
Radio and Audio Frequency Circuits (*See also large diagram in envelope*)



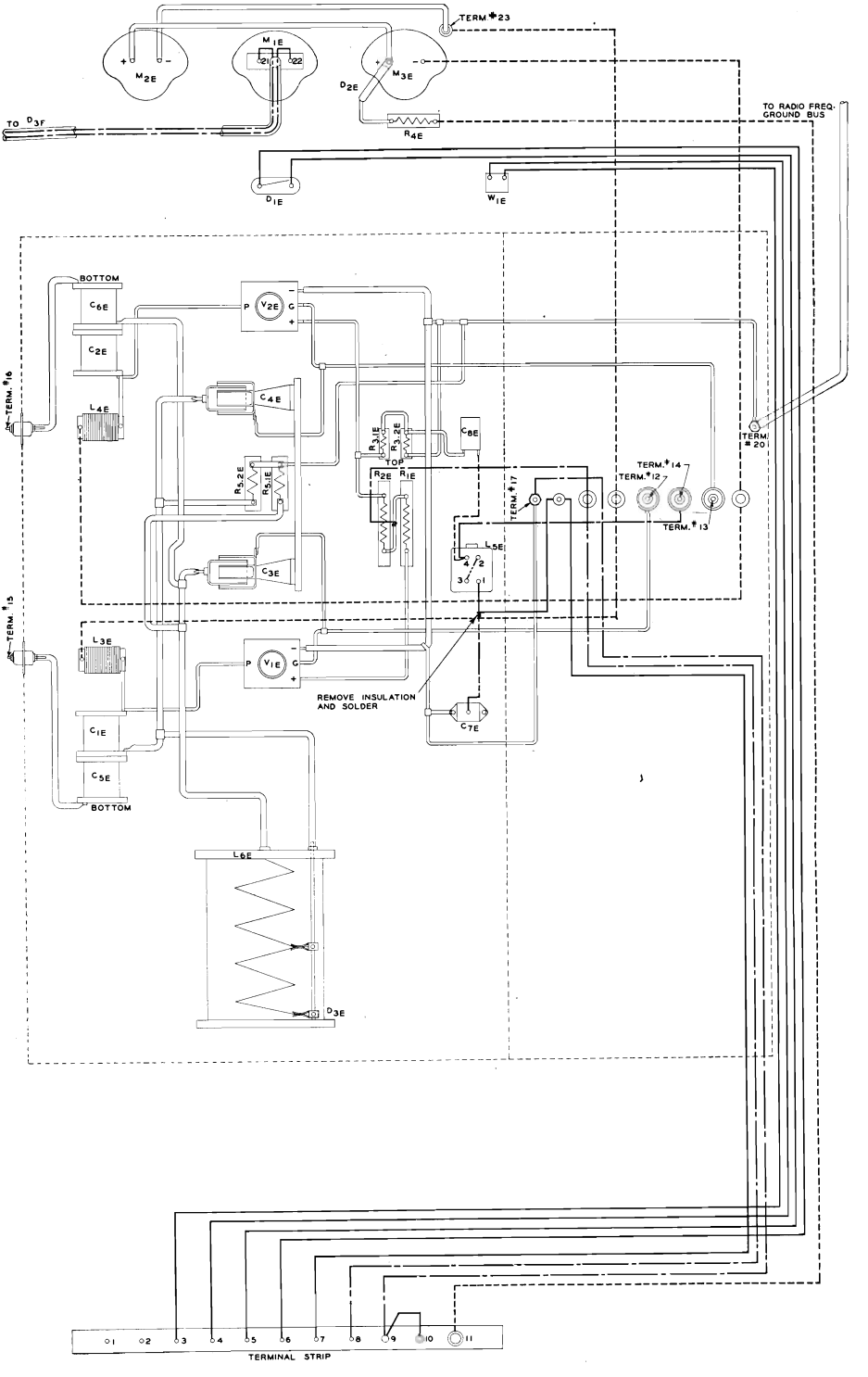
Schematic of No. D-85489 Oscillator Modulator Unit
(See also large diagram in envelope)



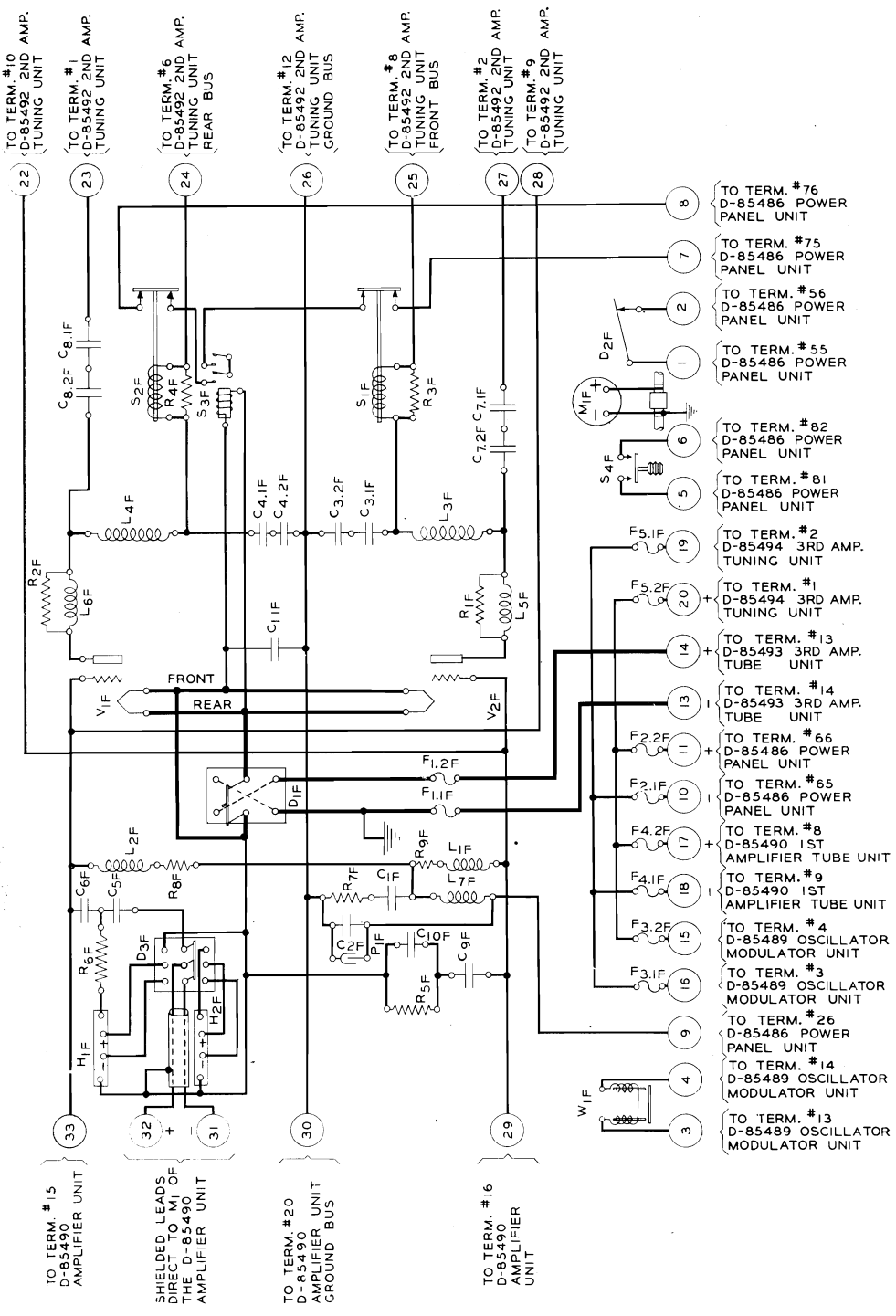
Wiring Diagram of No. D-85489 Oscillator Modulator Unit
(See also large diagram in envelope)



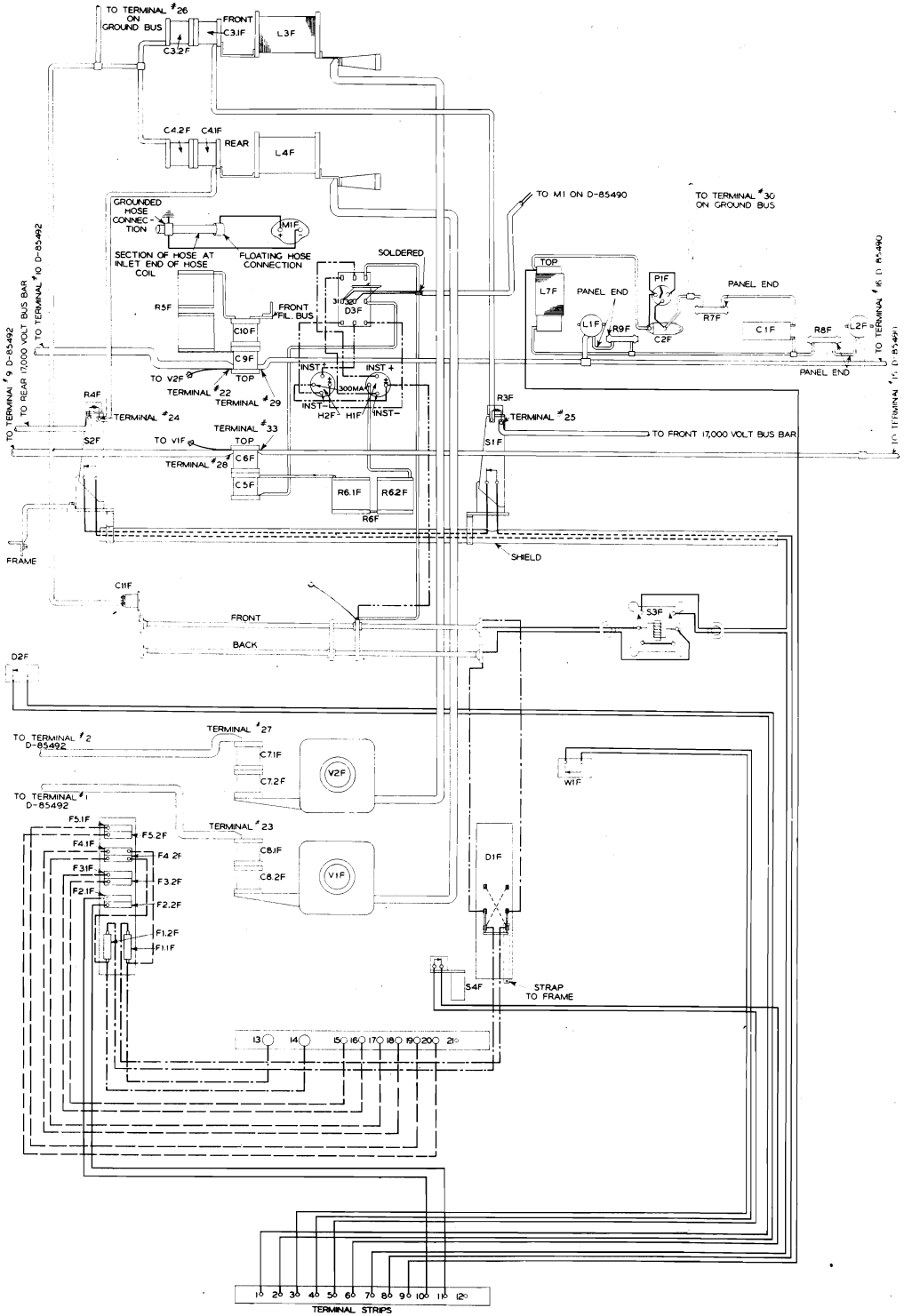
Schematic of No. D-85490 First Power Amplifier Unit



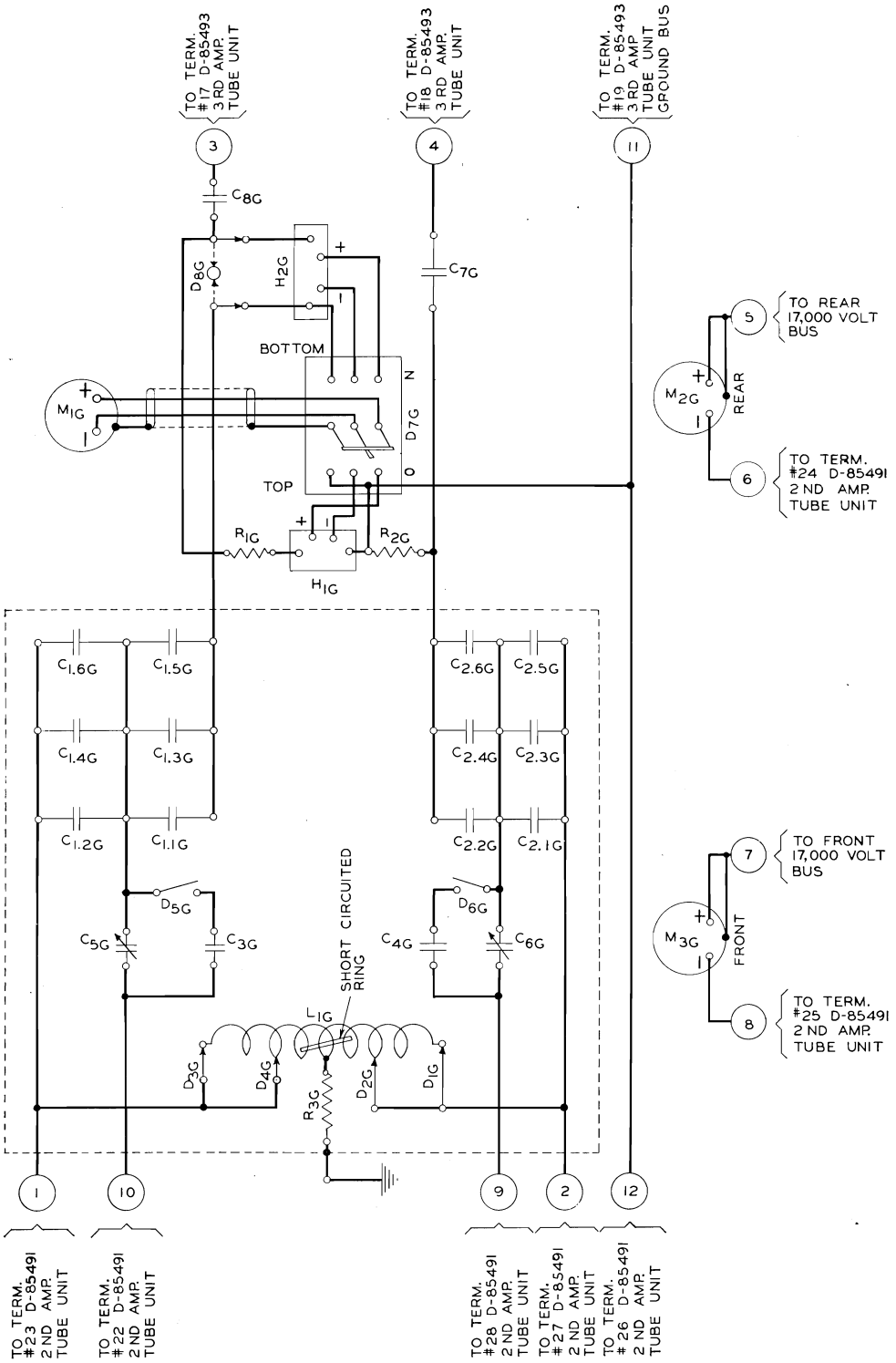
Wiring Diagram of No. D-85490 First Power Amplifier Unit
(See also large diagram in envelope)



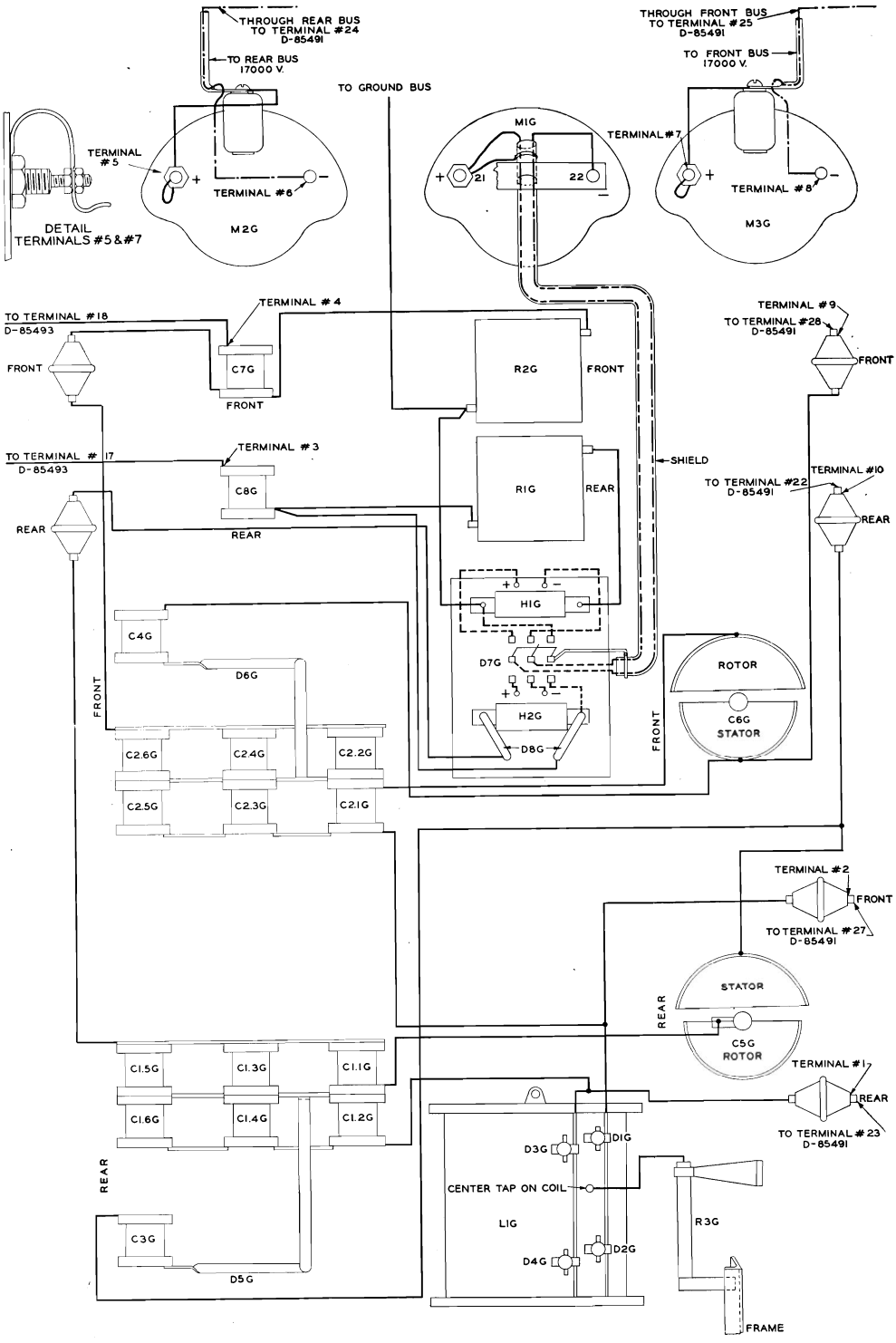
Schematic of No. D-85491 Second Power Amplifier Tube Unit



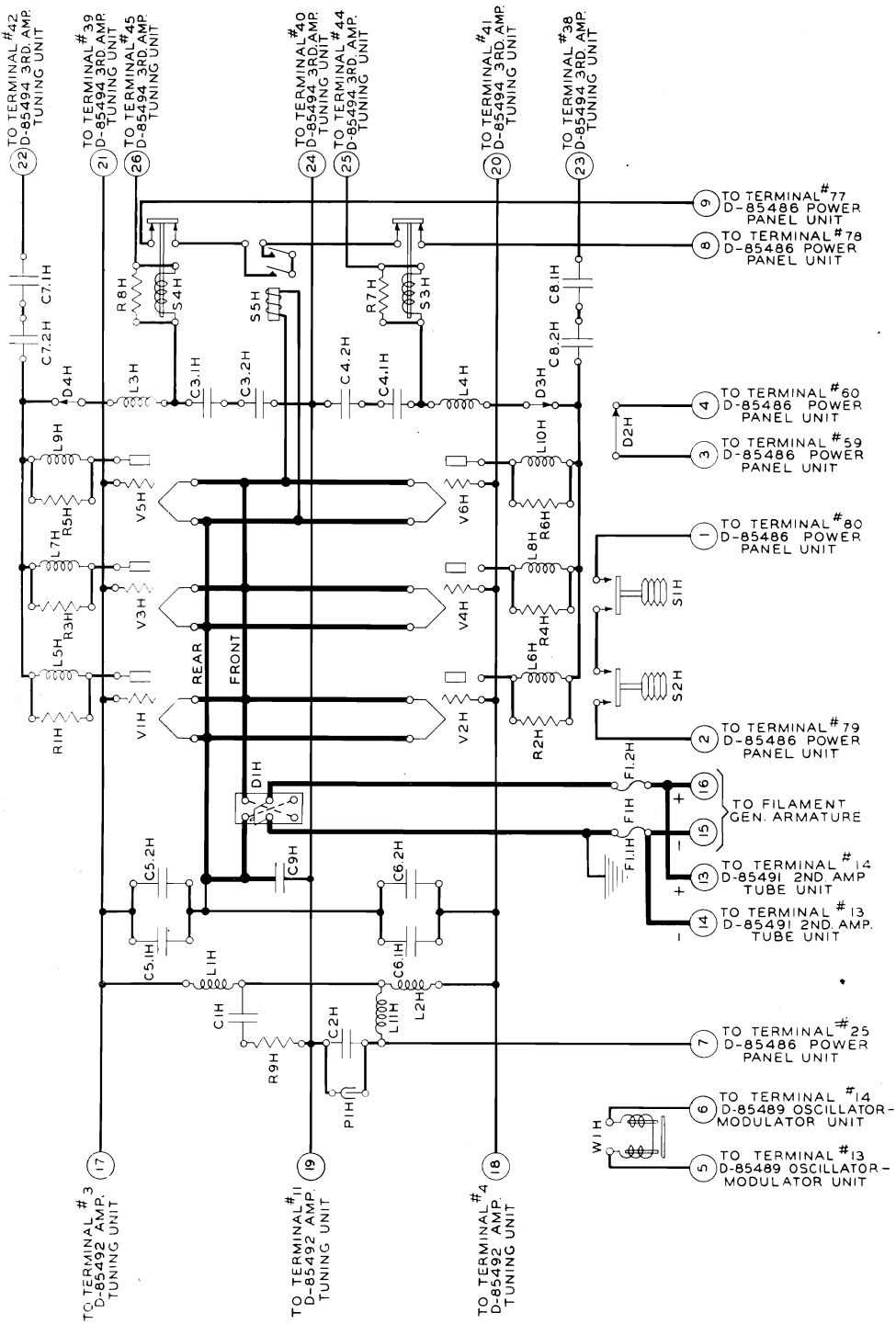
Wiring Diagram of No. D-85491 Second Power Amplifier Tube Unit
(See also large diagram in envelope)



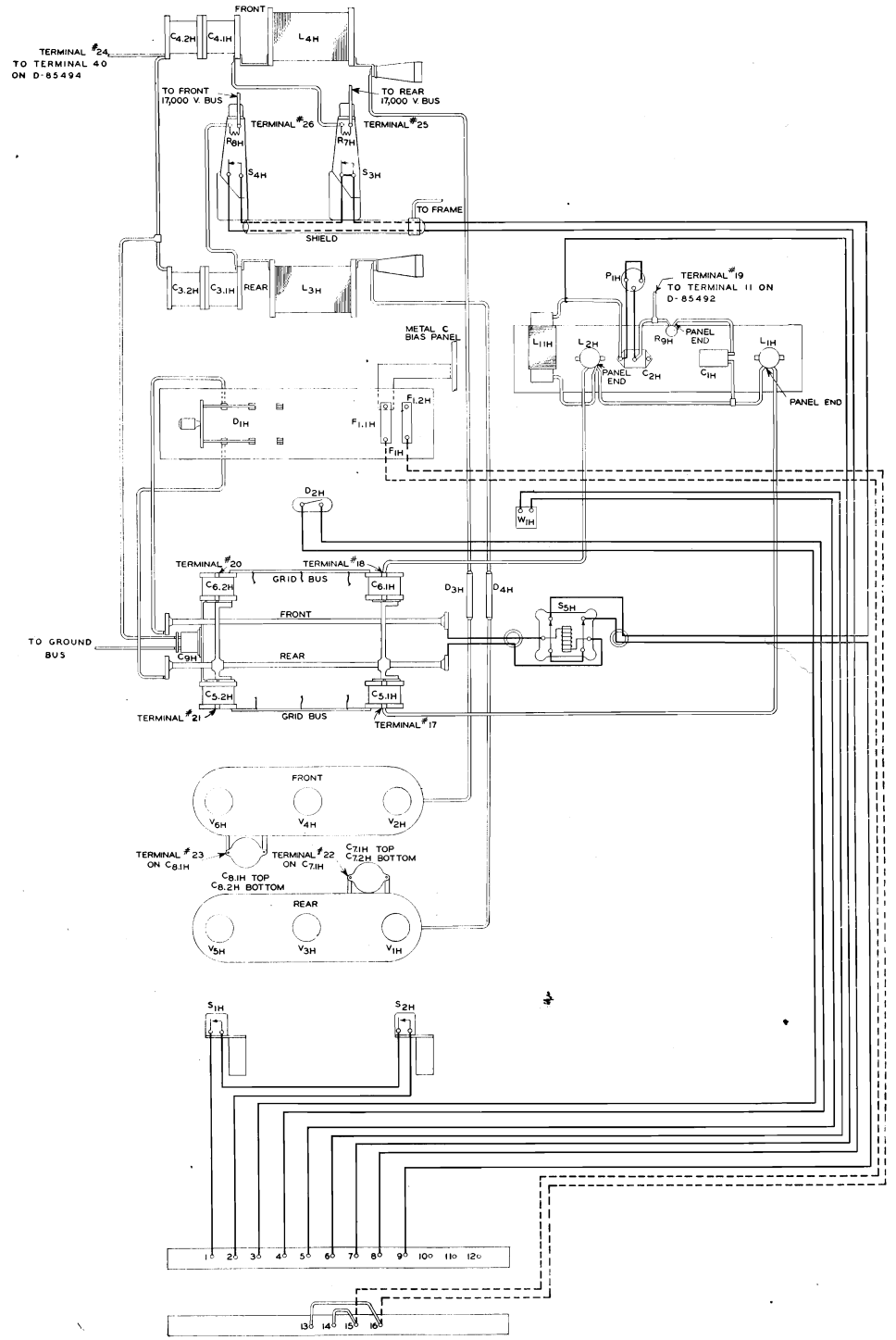
Schematic of No. D-85492 Second Power Amplifier Tuning Unit



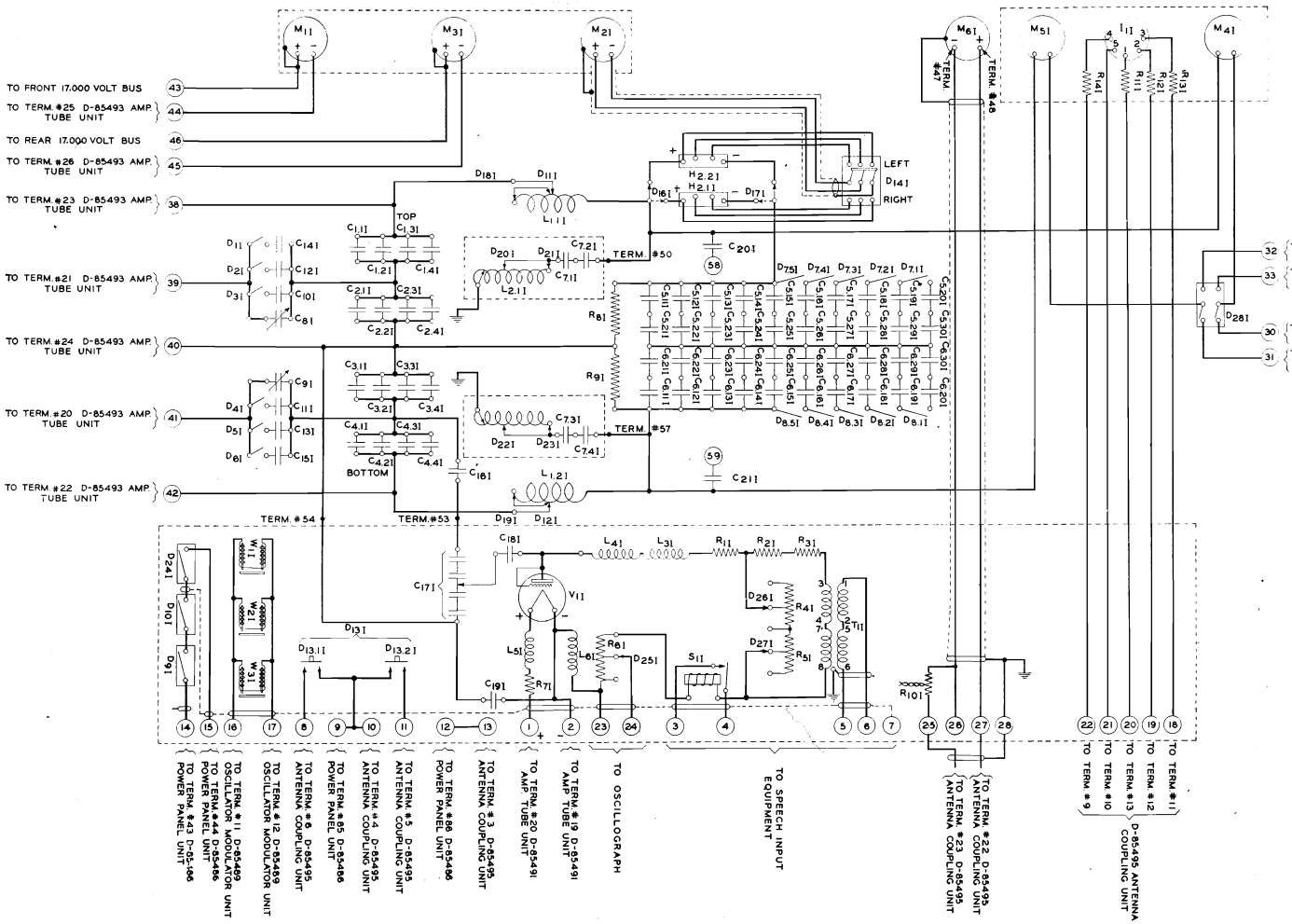
Wiring Diagram of No. D-85492 Second Power Amplifier Tuning Unit



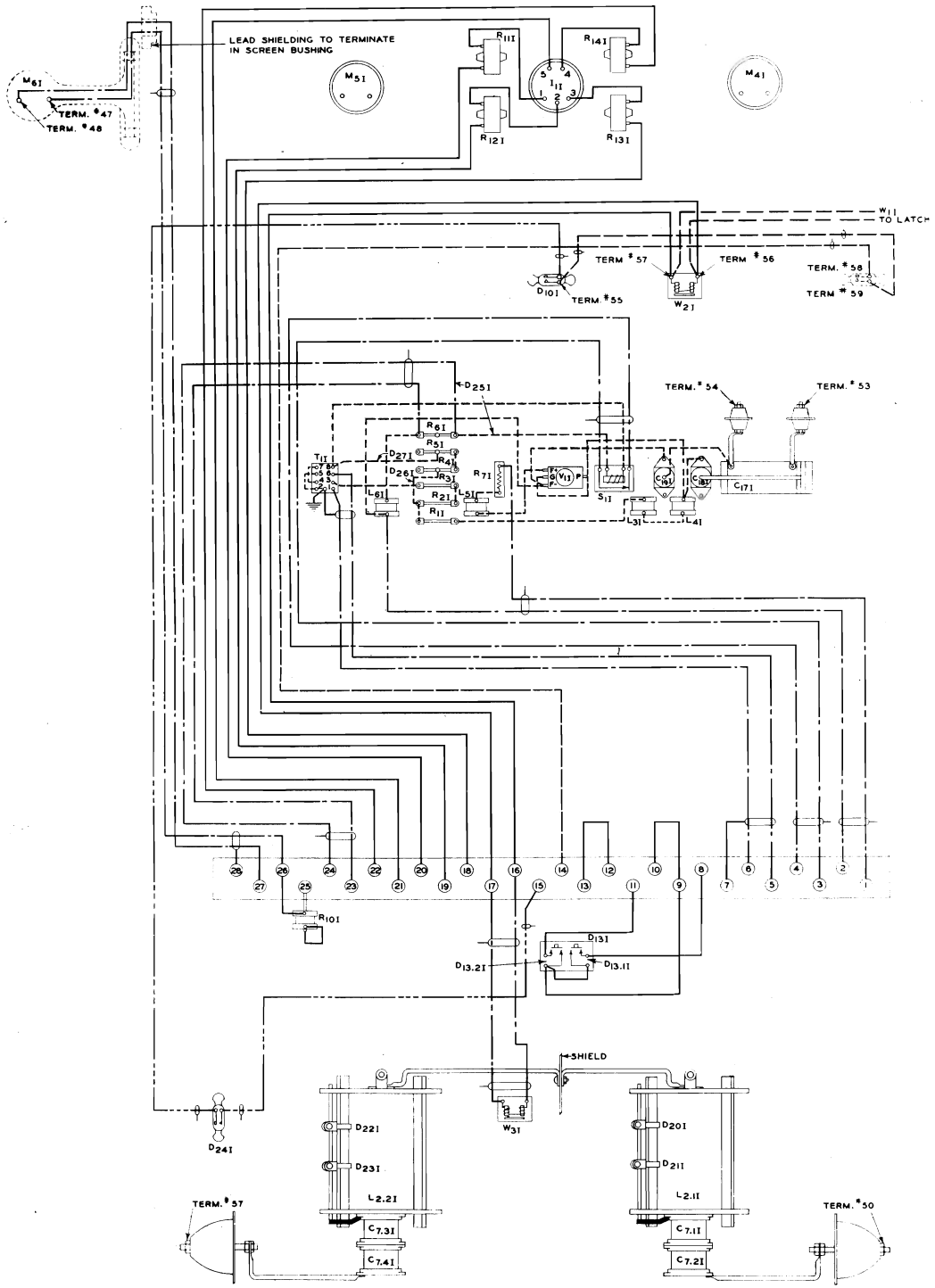
Schematic of No. D-85493 Third Power Amplifier Tube Unit



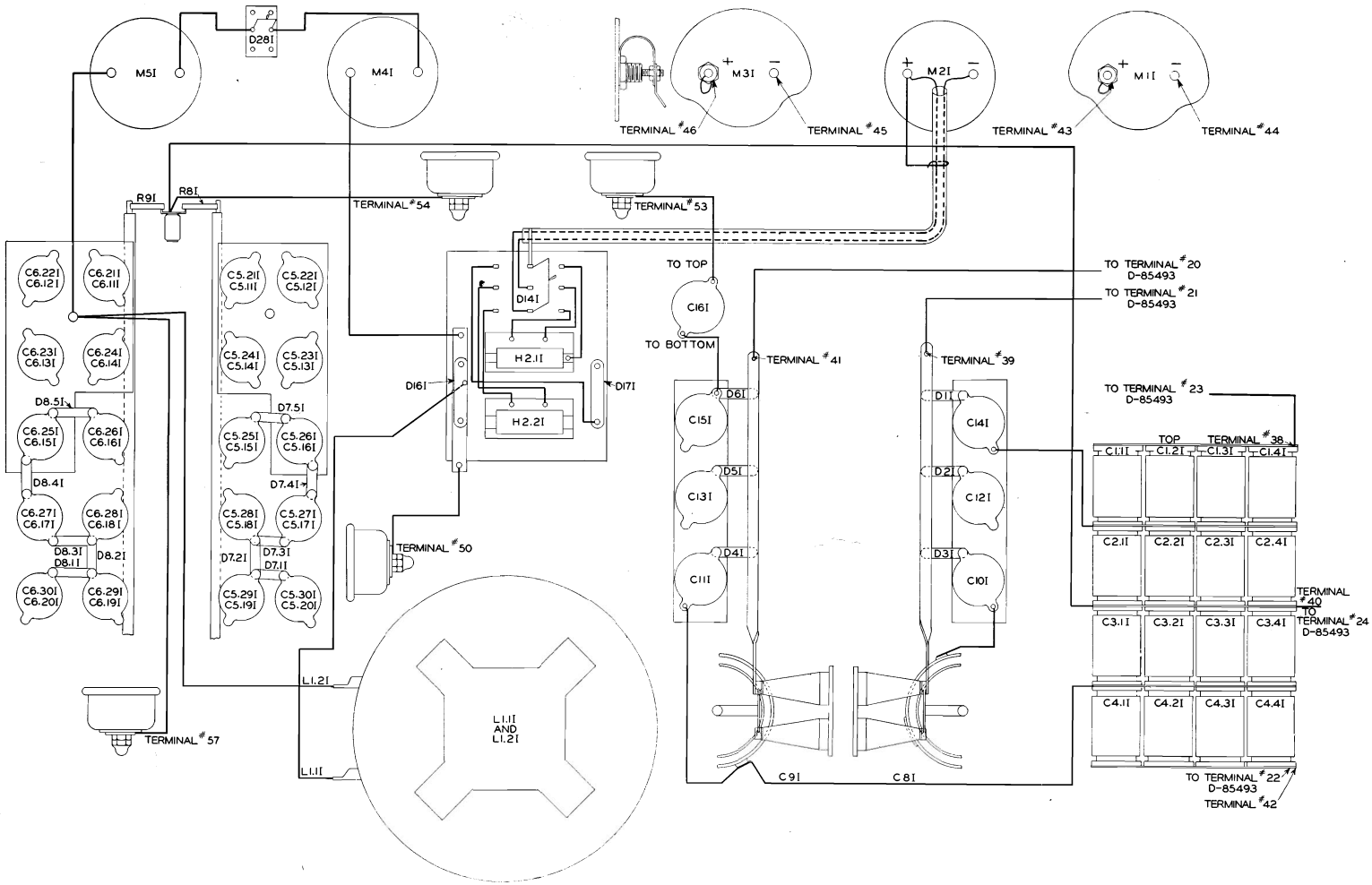
Wiring Diagram of No. D-85493 Third Power Amplifier Tube Unit



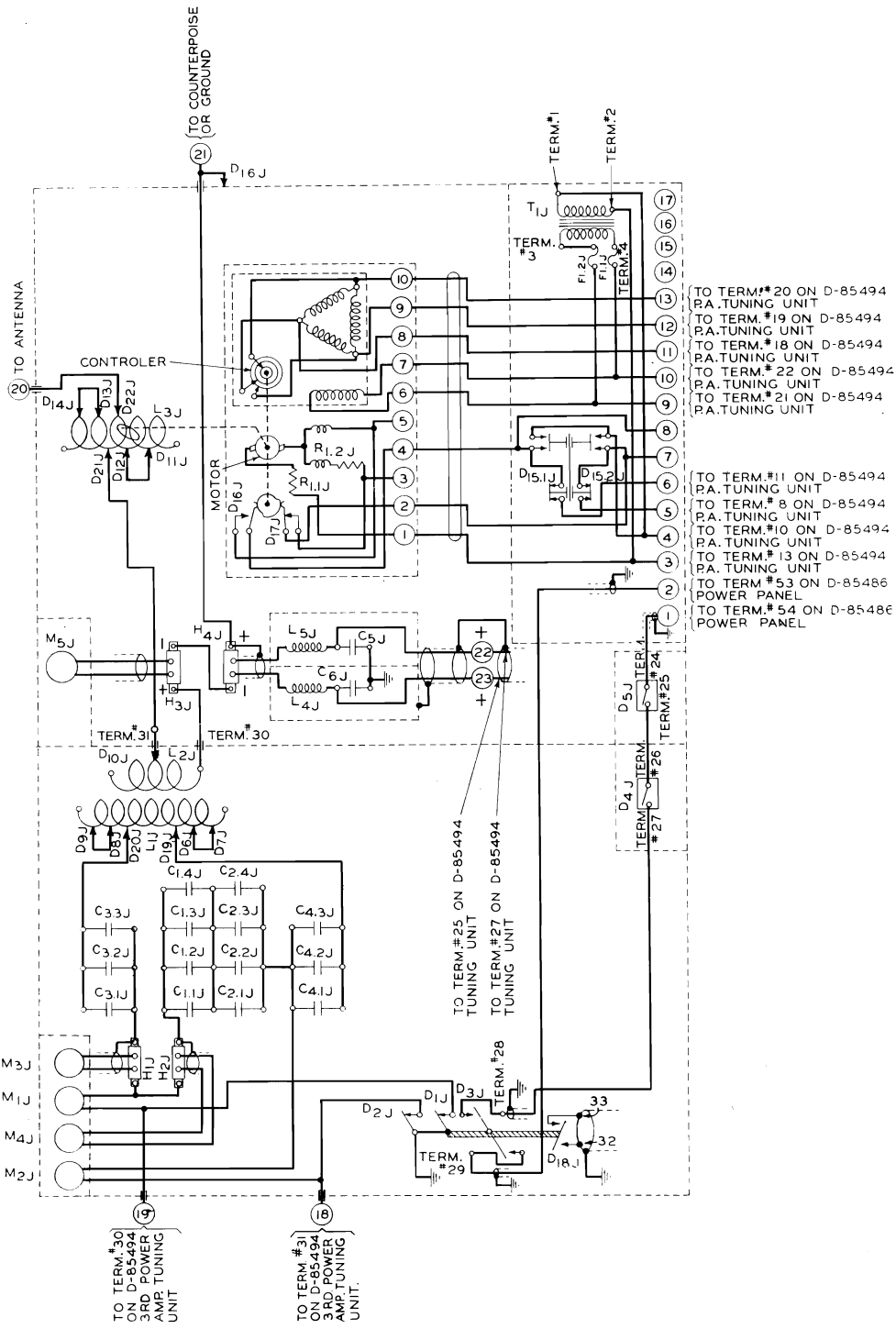
Schematic of No. D-85494 Third Power Amplifier Tuning Unit



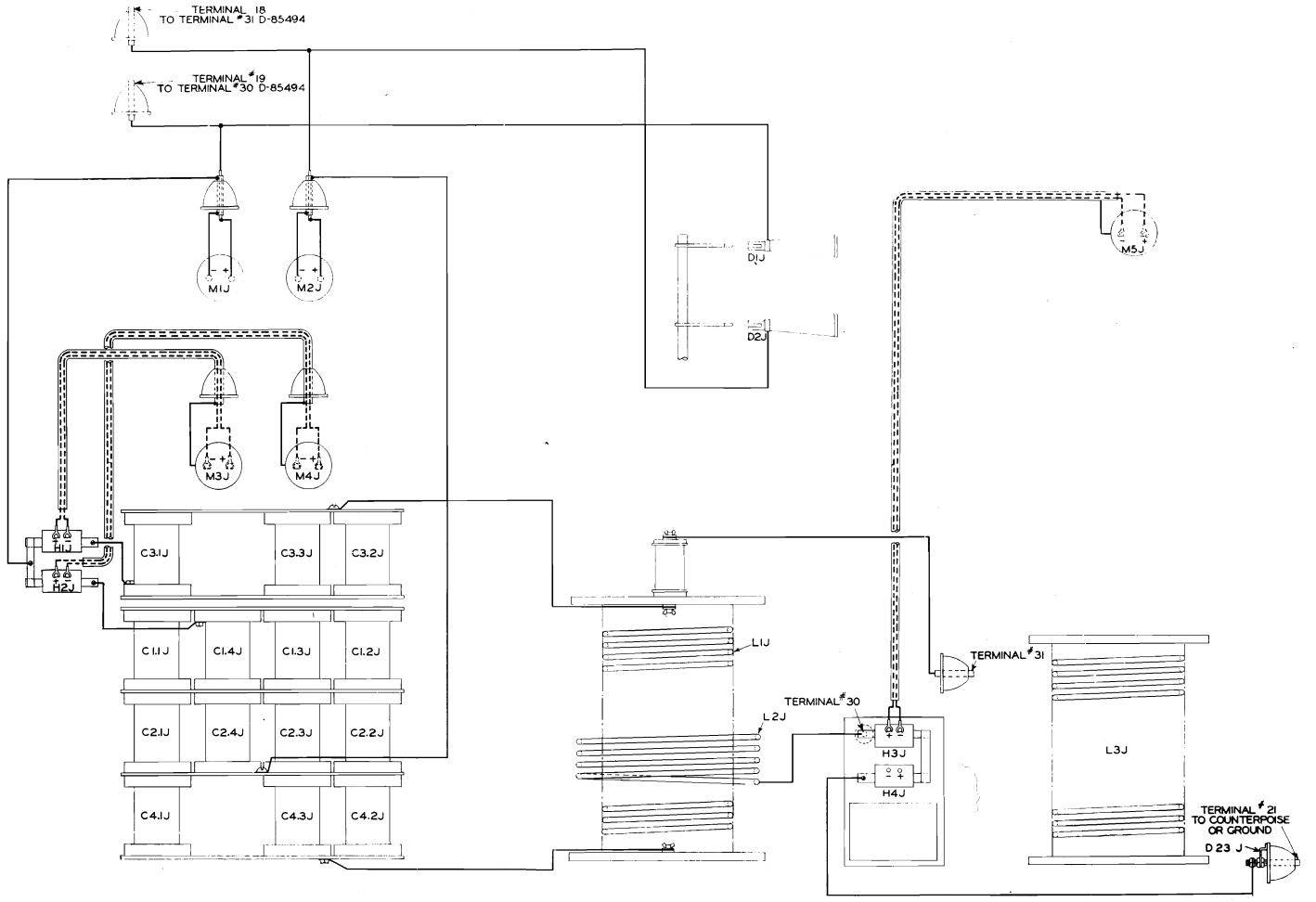
Wiring Diagram for Right-Hand Panel of No. D-85494 Third Power Amplifier Tuning Unit



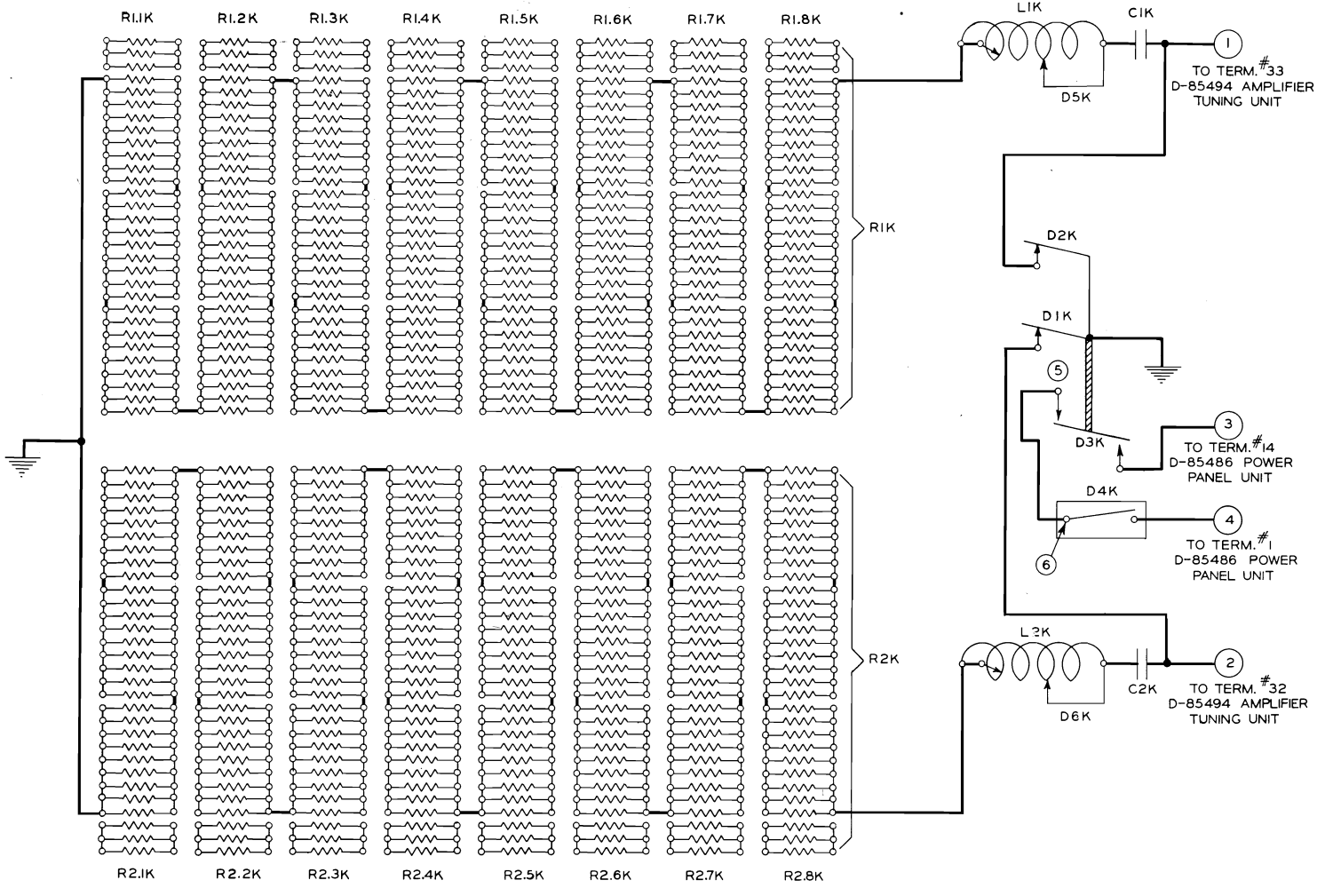
Wiring Diagram of Left-Hand Panel of No. D-85494 Third Power Amplifier Tuning Unit
(See also large diagram in envelope)



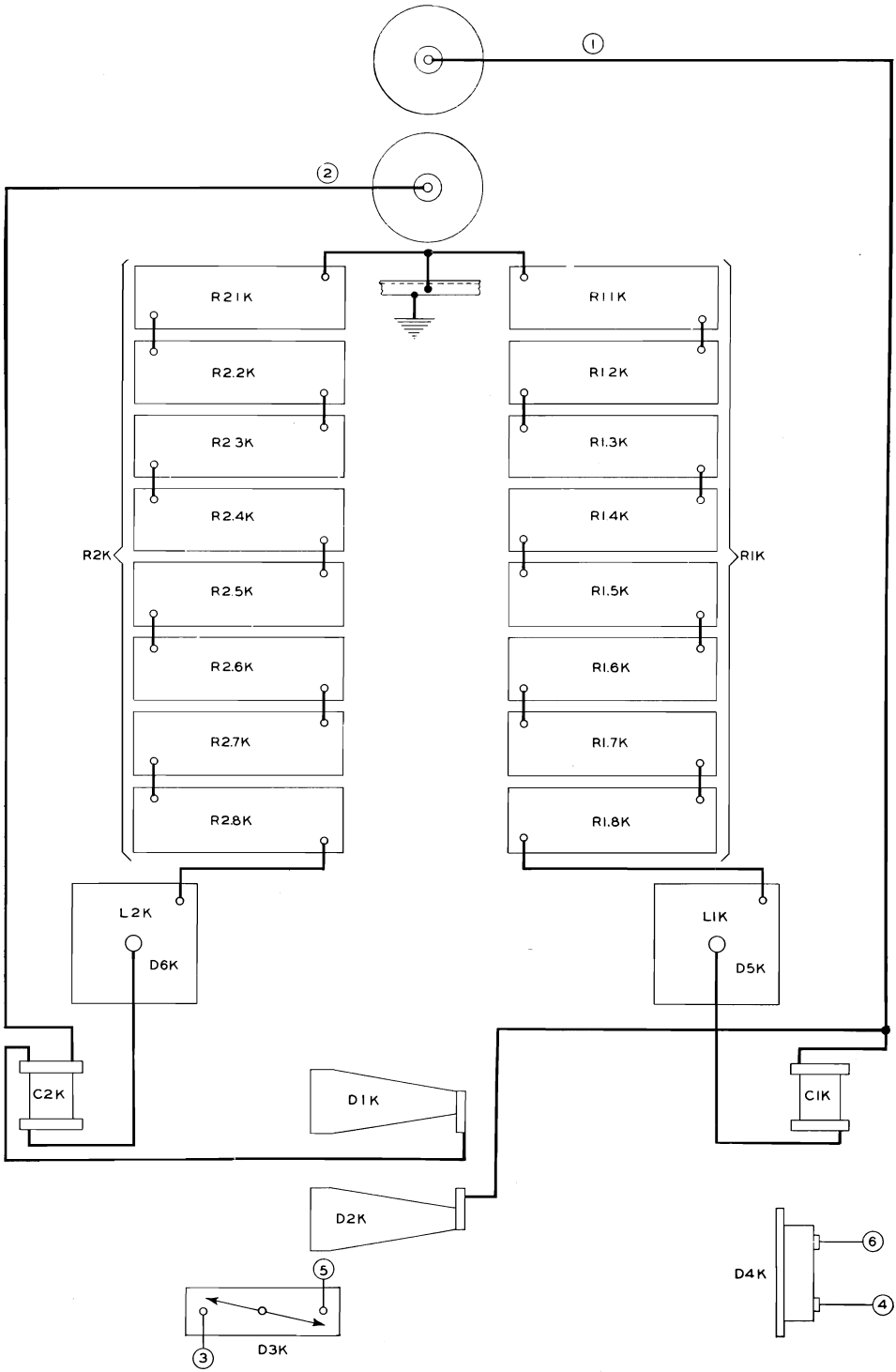
Schematic of No. D-85495 Antenna Coupling Unit



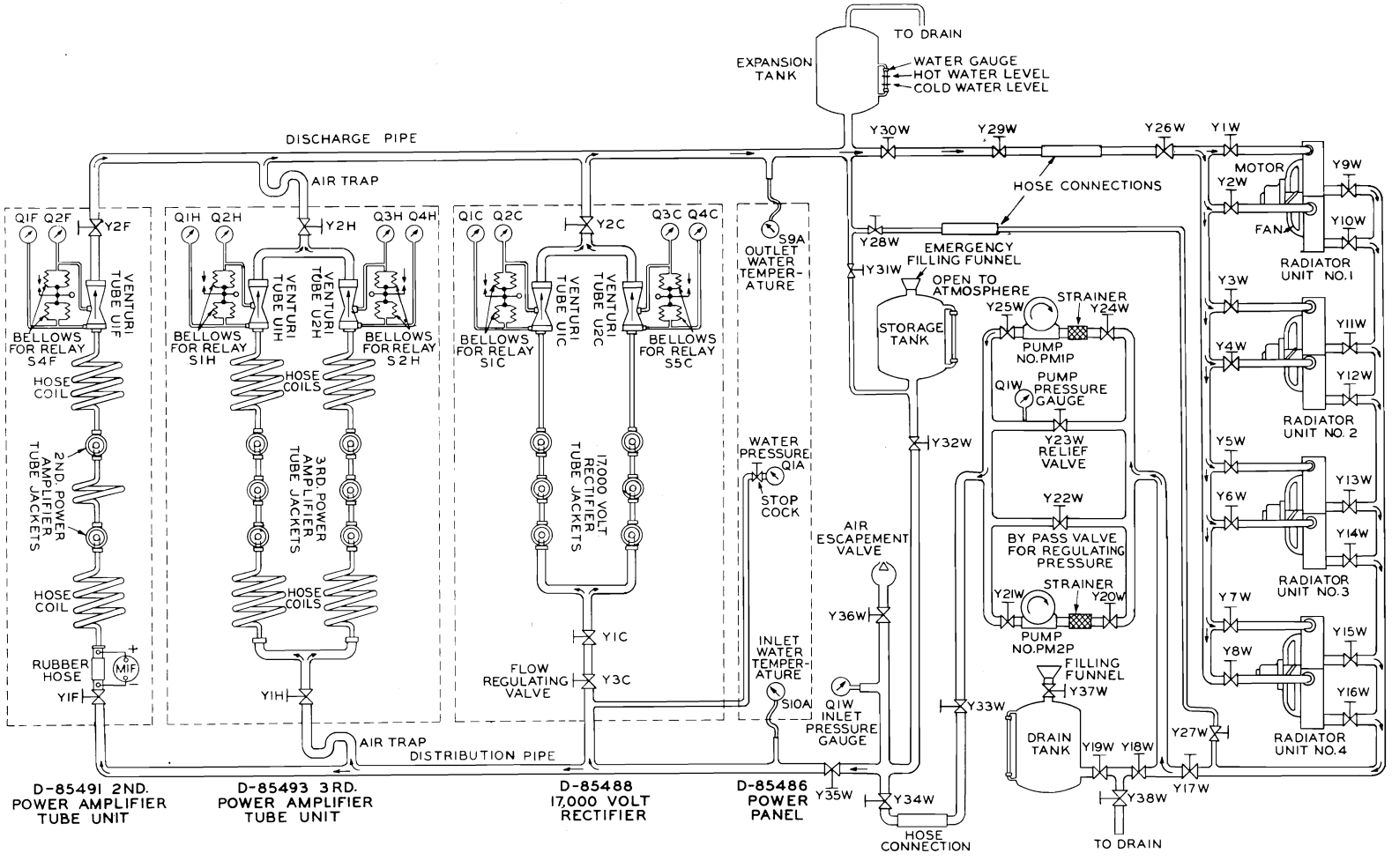
Wiring Diagram of No. D-85495 Antenna Coupling Unit



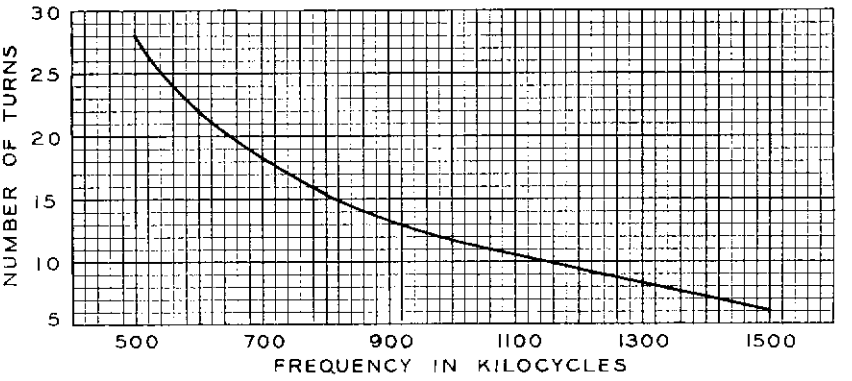
Schematic of No. D-86650 Artificial Antenna Unit



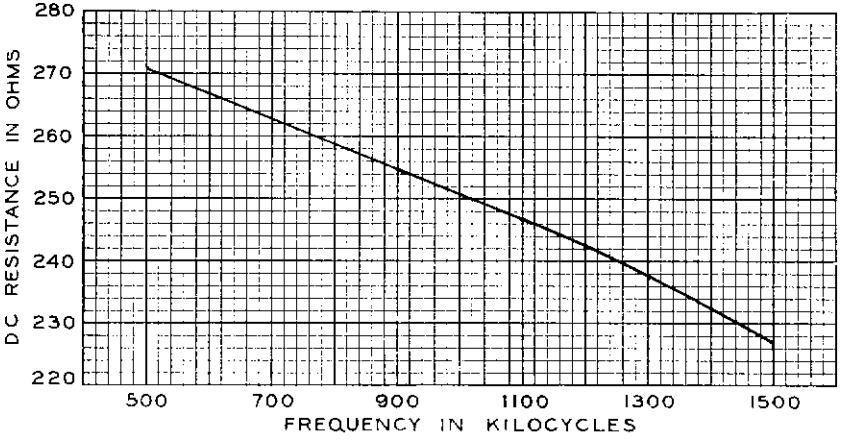
Wiring Diagram of No. D-86650 Artificial Antenna Unit



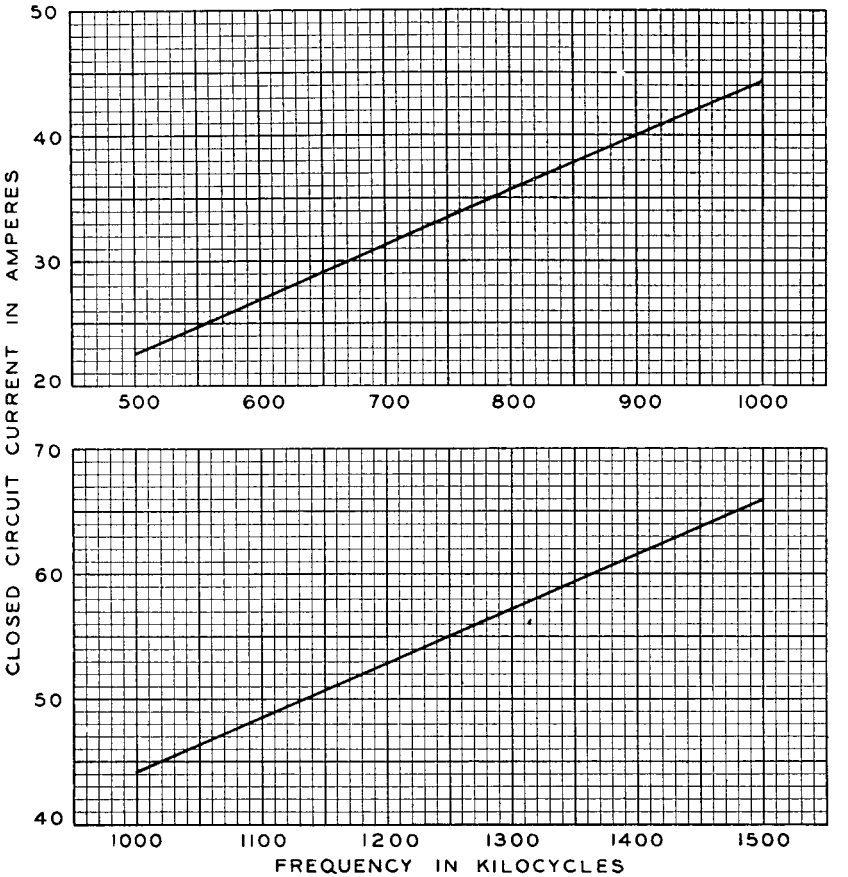
Schematic of Water Cooling System



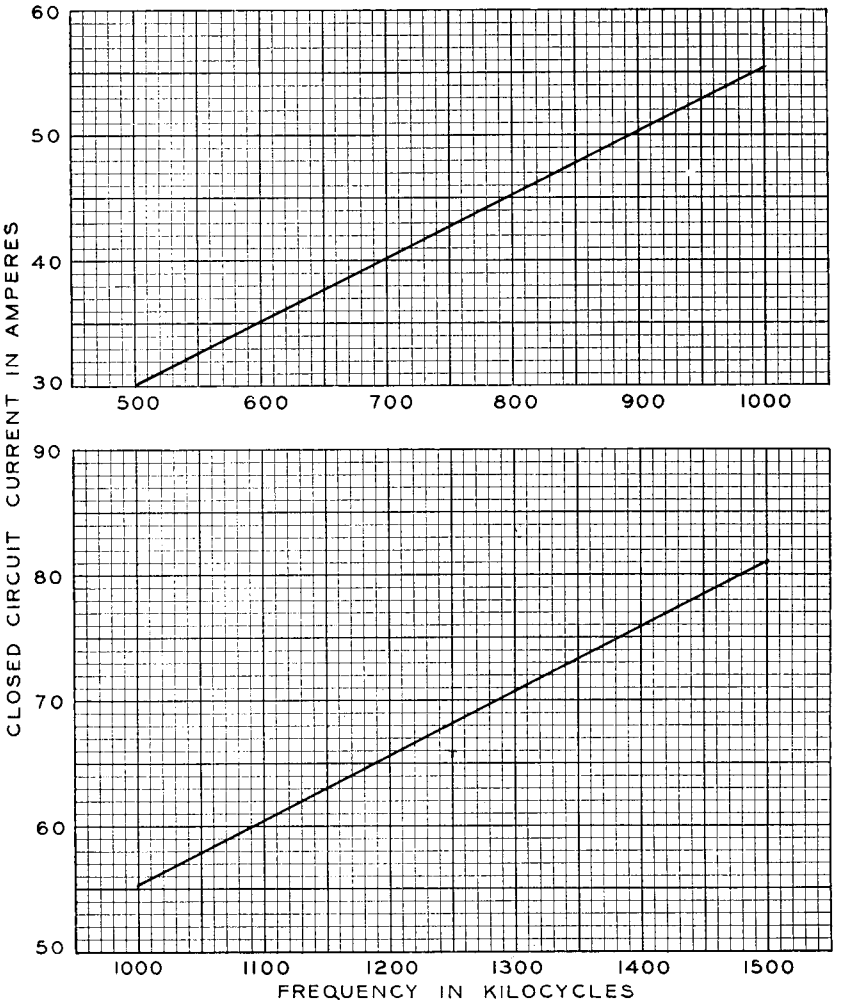
Adjustment of Artificial Antenna Tuning Coils L1K and L2K



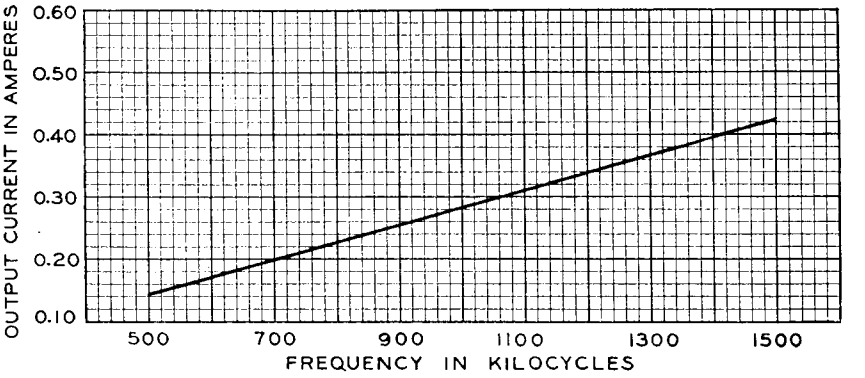
Adjustment of Artificial Antenna Resistances R1K and R2K



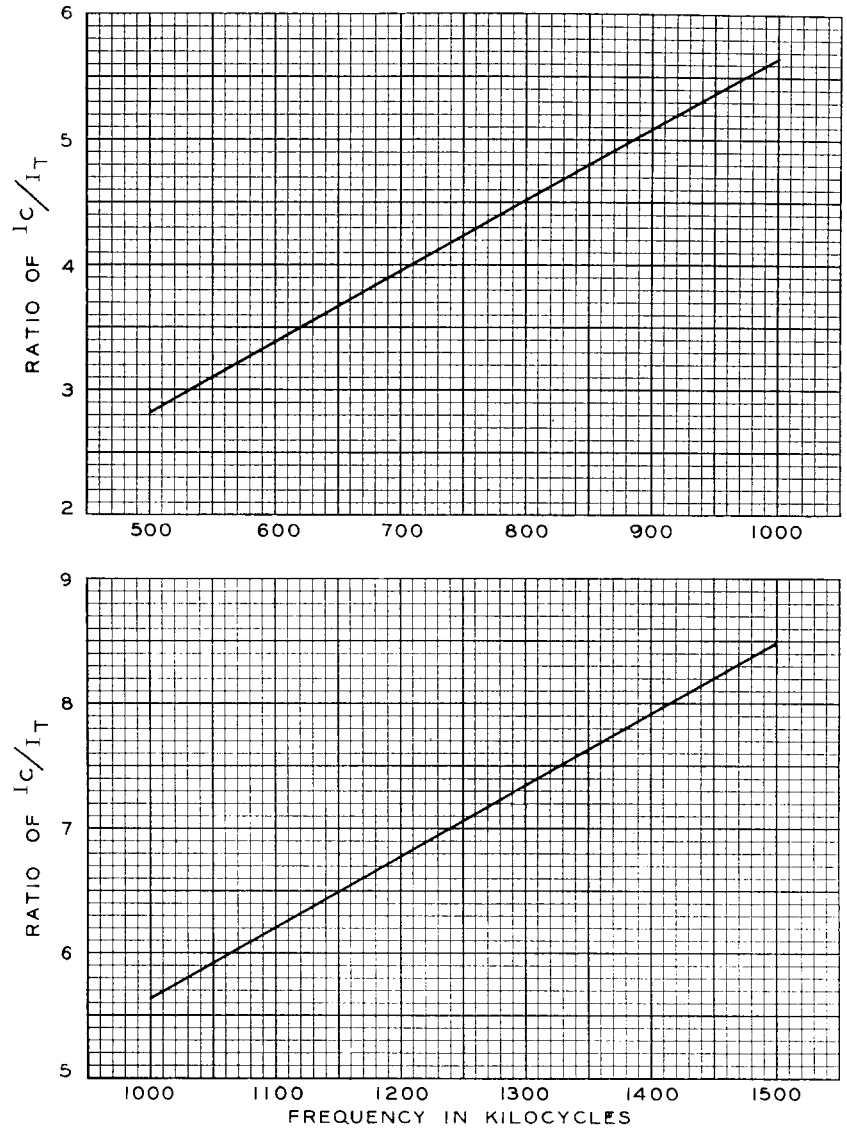
Closed Circuit Current in Antenna Coupling Unit for 50 Kilowatts



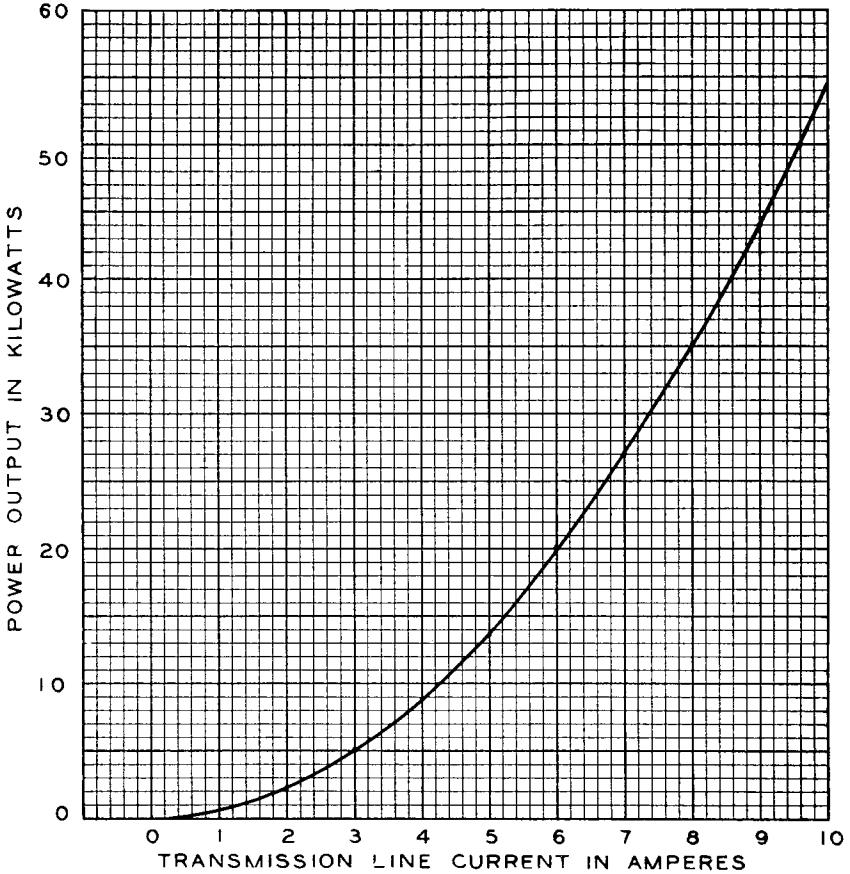
Closed Circuit Current in Third Power Amplifier Tuning Unit for 50 Kilowatts



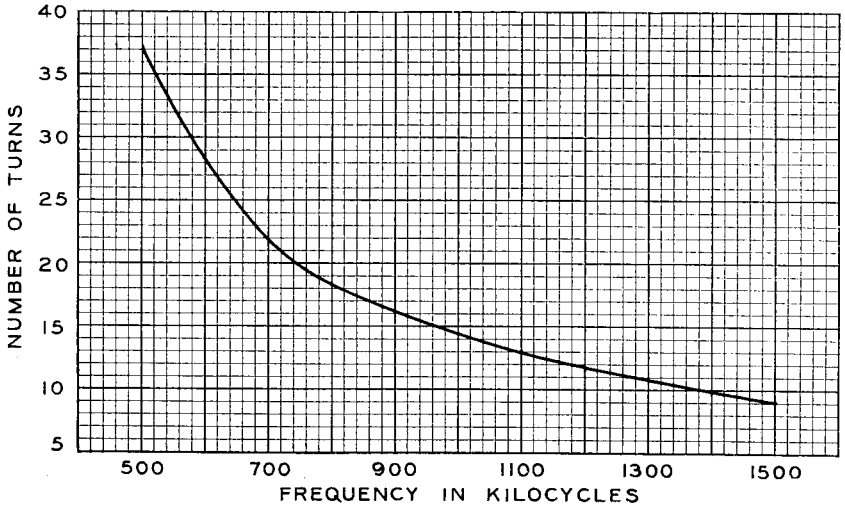
Output Current of Radio Frequency Amplifier in Oscillator Modulator Unit



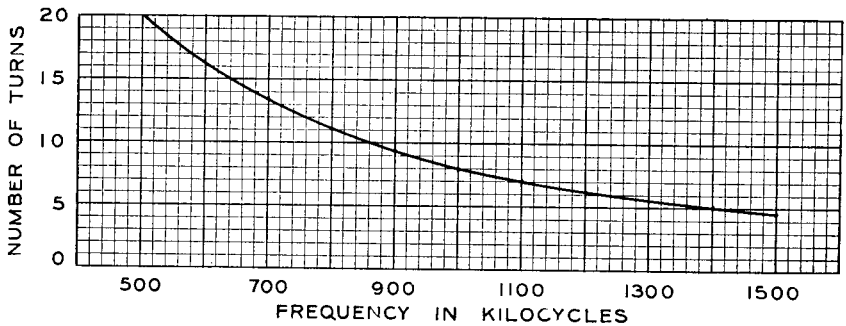
Ratio of Condenser Current to Transmission Line Current—Six Tubes in Third Power Amplifier



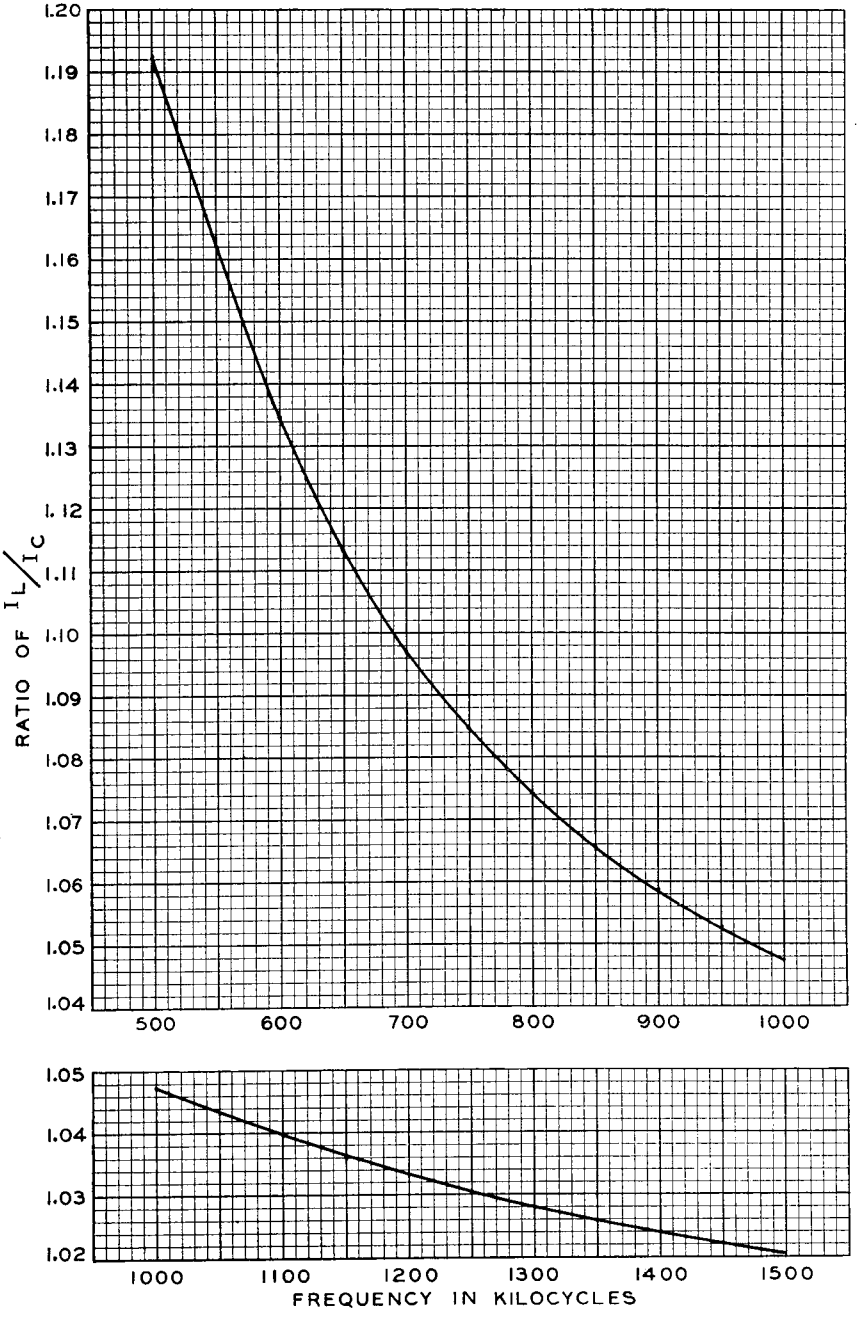
Output of Third Power Amplifier as Indicated by the Average of the Transmission Line Currents



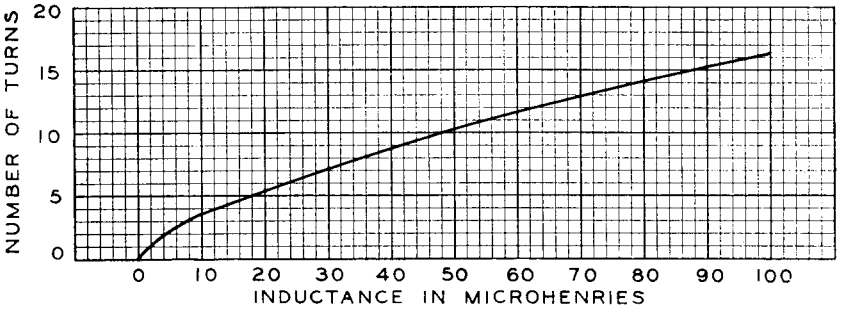
Adjustment of Harmonic Shunt Coils L2.1I and L2.2I



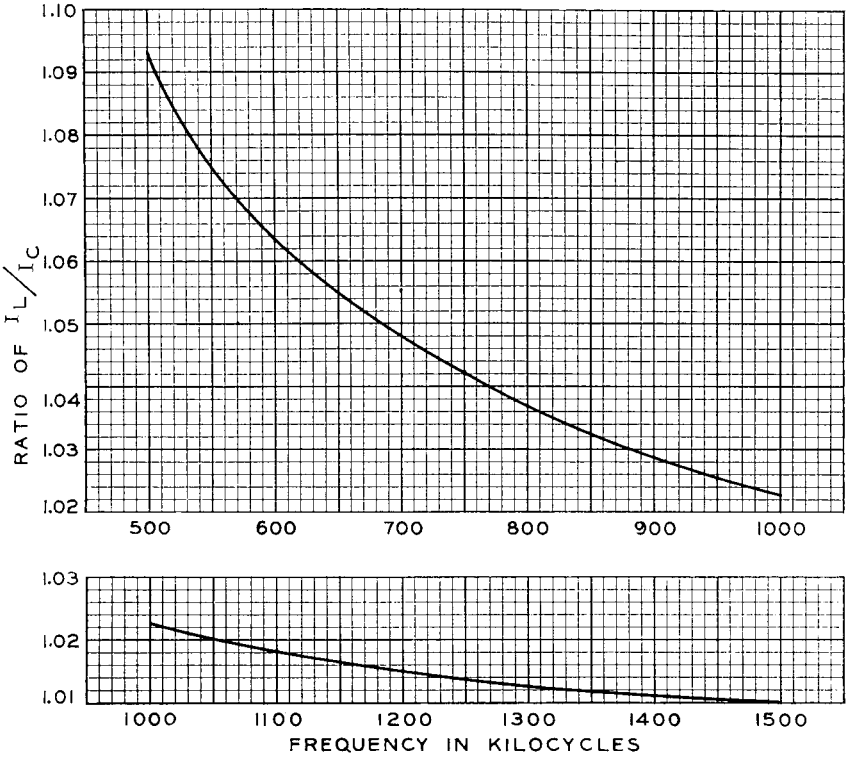
Adjustment of Coil L1J in Antenna Coupling Unit



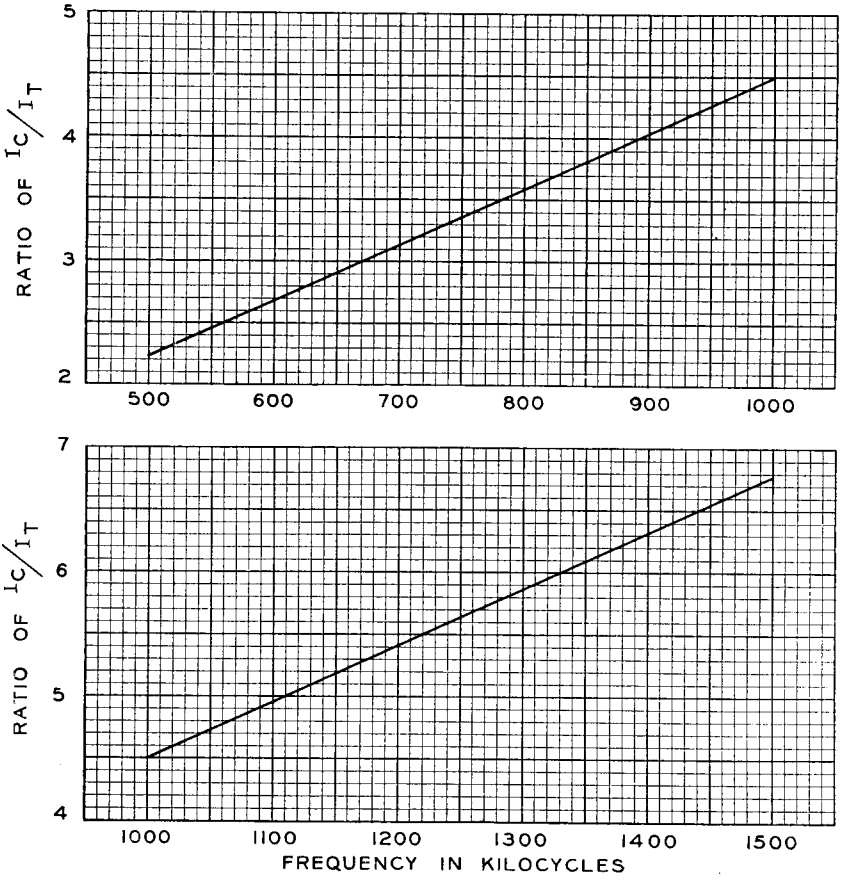
Ratio of Inductance Current to Capacity Current in Antenna Unit—Antenna Disconnected



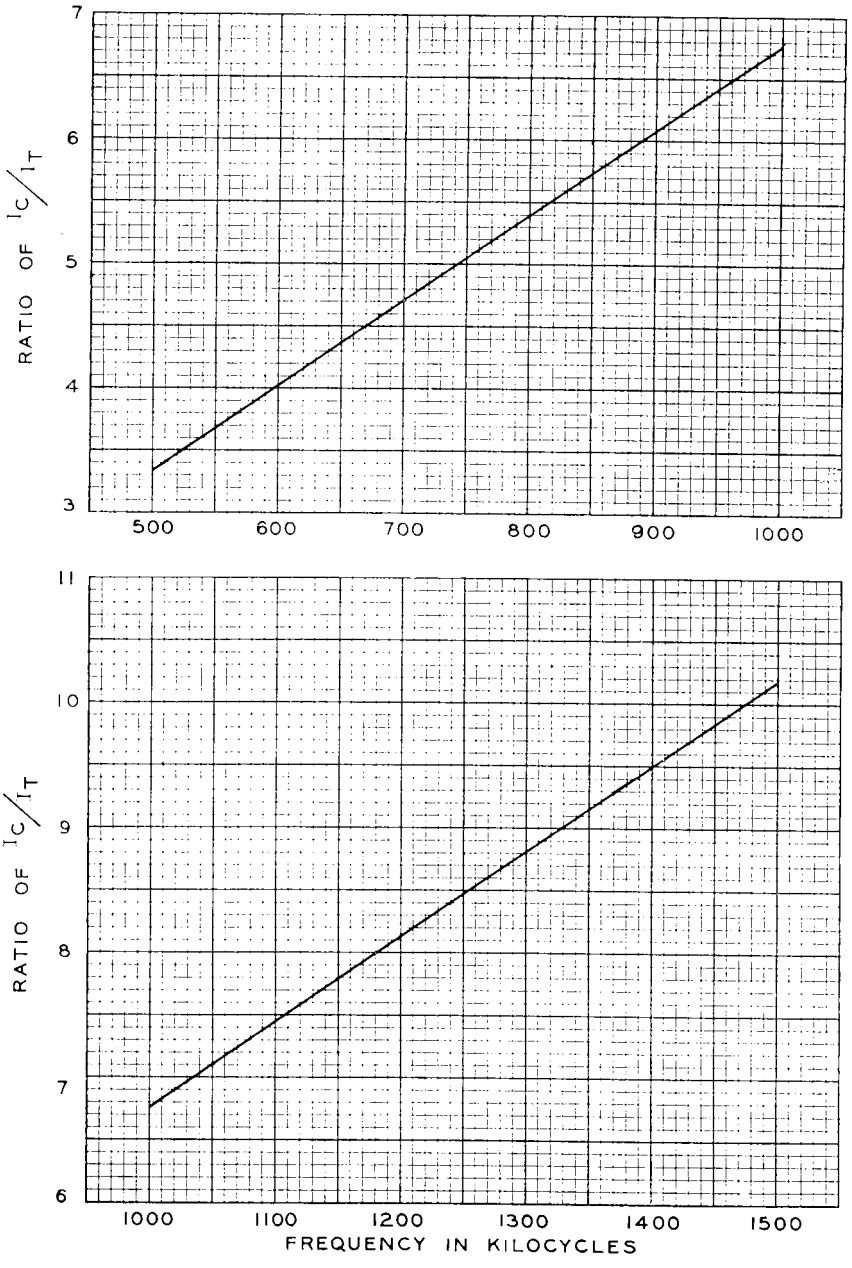
Inductance of Antenna Loading Coil L3J



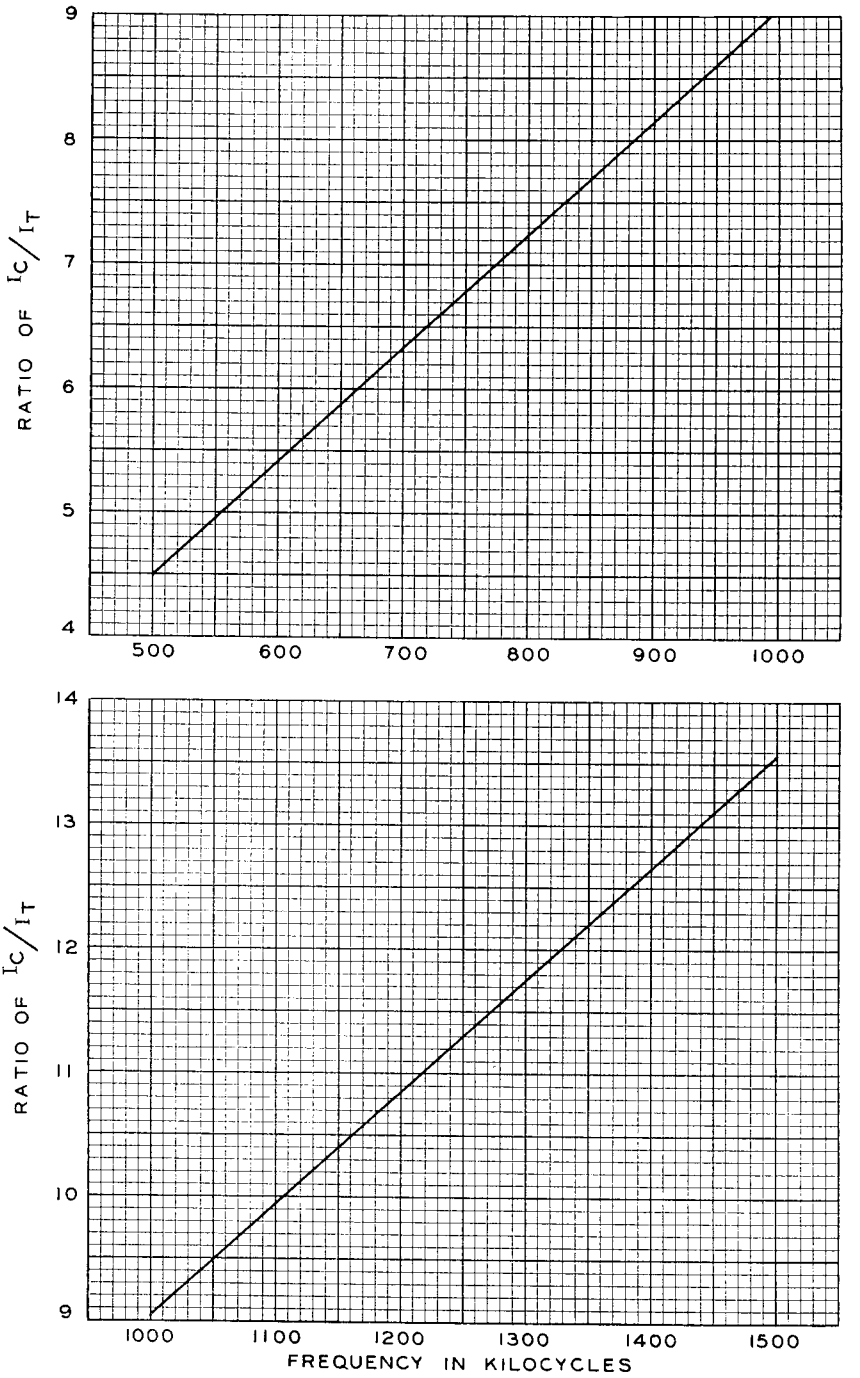
Ratio of Inductance Current to Capacity Current in Antenna Unit—Antenna Connected



Ratio of Condenser Current to Transmission Line Current for Antenna Coupling Circuit



Ratio of Condenser Current to Transmission Line Current—Four Tubes in Third Power Amplifier



Ratio of Condenser Current to Transmission Line Current—Two Tubes in Third Power Amplifier

INDEX

MEMORANDA

Hose changes

Feb 10 - 33 - 3rd, rear
Feb 17 - 33 - 2nd, back
Apr 30 - 33 - 3rd rear, short leng ths not changed.
Aug 30 - 33 - 2nd P.A. - front & rear connecting hose changed.

Dec. 1st 1933 ALL THIRD HOSE NEW
Jan 13th 1934 All 2nd PA hose renewed.
Jan 17th 1934 all 17 KV. RECT. HOSE NEW.

MEMORANDA

Circuit changes —

Sunday October 15, 1933

terminals 85 & 86 on unit "A" cleared of 220 v A.C. and leads from control circuits to 17000 volt magnetic switch coil put thereon. On front of terminal strip #280, #406 #114 and #405 were connected to #86. On #85 was connected #115 — three four wires from console. Also extended leads to coil of switch in trans. room.

Cleaned #53 & #54 (old dummy antenna) and placed jumper between #52 & #55 leaving #53 & #54 for console connection.

Removed ~~the~~ jumper from between #68 and #69 —

#69 bare on rear — has wire #64 and #147 on front. (#147 from console)

Terminal #68 ~~has wire #68~~ on front and lead from "off" contact "D4A" on rear

terminal # 3 has lead from "S2A" contact on rear — wire # 146 from console on front.

terminal # 89 added — wire # 144 from console to #89 — to starting contact on "D4A" (via "S7A")

terminal # 90 added — wire # 145 from console to #90 — to common contacts on "D4A" (via "S7A")